MTM

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MTM

MTM ASSOCIATION FOR STANDARDS AND RESEARCH

The Journal of Methods-Time Measurement is dedicated to the technical aspects, application development and general news items concerning the advancement of MTM.

The Journal encompasses the fields of endeavor that were formerly publicized in the MTM Newsletter and MTM Bulletin.

The technical section of the Journal is concerned chiefly with recent research developments both from the established research program at The University of Michigan, Ann Arbor, Michigan, and from somewhat smaller allied projects being conducted throughout the Association membership.

New applications of MTM as well as refinements of established applications are presented in the Application Section to illustrate specific approaches to management problems that can be solved through the use of Methods-Time Measurement.

Current events in the lives of persons associated with MTM are described in the general news section.

The Editorial Staff welcomes contributions for all three sections described.

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May-August 1961

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Editor . . . . . Richard F. Stoll

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Editor's Note:

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TECHNICAL I

NEW RESEARCH TECHNIQUES IN WORK MEASUREMENT

by

WALTON M. HANCOCK

Associate Professor of Industrial Engineering, The University of Michigan

As a result of our recent research for the Methods-Time Measurement Association, two new techniques have been developed to collect the basic data needed to determine elemental motion times. These methods, which we will call the "Recorder" method and the "Electronic Data Collector" method, were developed primarily to overcome the inherent errors and difficulties in using micromotion pictures for this type of work. The purpose of this paper is to give a brief description of the new techniques and then to compare these techniques with the traditional motion picture method. Other potential uses of the new methods in the work measurement field will also be indicated.

THE RECORDER METHOD

A graphical recorder equipped with carrier amplifiers, such as the one pictured in Figure 1, is used to record the time values as well as the forces occurring within a given operation cycle. Recorders have been used for a long time in other fields of engineering to measure such things as position, velocity, acceleration, and temperature of machine components. However, to my knowledge, they have not been used extensively to measure human motions and the acting forces.

The Recorder, with the proper instrumentation, can give a graphical picture of the motion

Fig. 1

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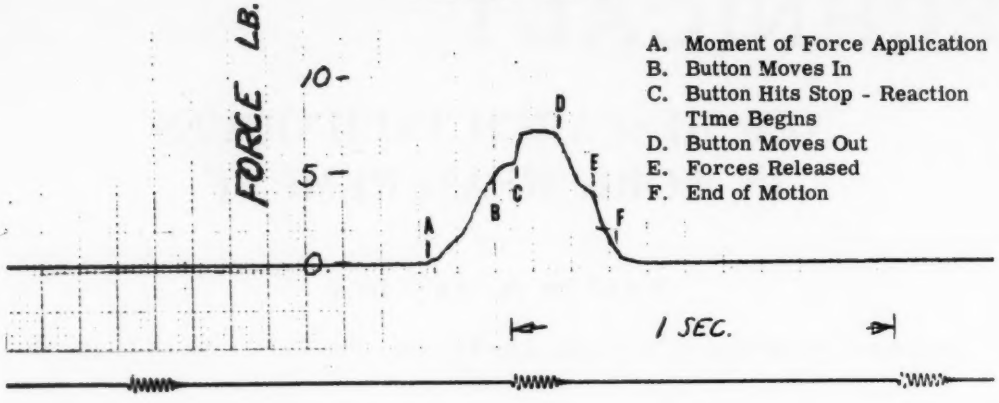

Fig. 2. "Measurement of Forces Occurring During The Activation of a Push Button"

of an operator in a work environment. For example, Figure 2 is an actual graph taken on a graphical recorder of an operator pushing a stop button on a machine. Time on the graph is measured horizontally, and force is measured vertically. One can get some idea of the elapsed time for the operation by noting the distance on the chart represented by one second. The particular points of contact and changes in the force in which one is interested are usually determined by noting the places on the graph where sharp changes in the direction of the curve occurs. For example, in Figure 2, points A, B, C, D, E, and F and the elapsed time between them can be determined. The resultant forces occurring in any part of the cycle can also be determined according to the scale on the chart.

In practice, recordings are made of the elements under study, and the points of interest are then read off manually and recorded. Since most of these points are represented by sharp changes in direction of the curves, and since the repeat cycles have the same form the reduction of the data is a relatively easy, though time consuming task.

In order to use this technique successfully, considerable attention has been paid to the methods of instrumenting the Recorder. We have found the use of pressure sensitive paints, contact switches, microswitches, and particularly small transducers to be successful methods of obtaining the input for the Recorder. Other methods, such as photocells, accelerometers, and potentiometers, can also be used when necessary. By experience, we have been able to find ways of positioning the various input devices on the machines so that they do not interfere with the performance of either the machine or the operator. Since we are using very sensitive equipment, it is also possible to use the body as part of the electrical circuit with success.

We have used the Recorder method in our MTM research for the past two years, and have recently completed a study of the MTM element "Apply Pressure" by use of this method. Much of the data collected were obtained by setting up the Recorder on actual industrial operations in manufacturing concerns in Michigan and Ohio. In the study of elements, such as "Apply Pressure," where the forces applied are a major variable, motion pictures are of little use.

In our research, we have used two of the channels of the Recorder pictured in Figure 1. Since each channel records a particular aspect of the operation, it has been possible to simultaneously record information from two input sources at the same time. There are a number of areas in the work measurement field where we feel that more than two channels will be required. For example, much more information might be necessary if one were to undertake studies of simultaneous motions. The Recorder in the picture, when it is equipped with the proper number of amplifiers, is capable of recording up to eight channels simultaneously.

THE ELECTRONIC DATA COLLECTOR

This method uses the same type of instrumentation as the Recorder. The electrical signals are picked up from the input devices previously discussed; however, the similarity between the methods stops at this point. The electrical signals are fed into the Data Collector, and the elapsed time of each element is punched on paper tape. The points between which time intervals are desired have to be programmed into the Collector. This is accomplished by means of a plug-in logic board.

The Data Collector was designed primarily for the purpose of obtaining information on elemental motions. The machine is pictured in Figure 3. It can measure time intervals over a wide range—from 1/28,000 of a second to twenty-four hours or more. It was intentionally designed to be portable so that it can be taken into an industrial plant and located beside the machine or operation. A power supply of 110 A.C. is required.

Any statistical analysis that is necessary on the data can be performed by feeding the tape directly into a computer equipped for tape input such as the Royal-McBee LGP-30. For computers equipped with card input, the tape can be fed through a tape-to-card converter and the cards used as input to the computer.

The Data Collector system has just recently been completed. Since we have already obtained considerable experience in the application of the various types of input devices that are necessary to set the Collector up on industrial operations, we anticipate that little time will be lost in putting the Collector to use as part of our research efforts.

For an example of the type of information that one is able to obtain on the Collector, please refer to Figure 2. The Collector can be programmed so that the time between the points marked on the graph, denoted as A, B, C, D, E, and F, can be punched on the tape. Since the paper tape can subsequently be put into a computer, no manual reduction of data is required.

We designed the Collector so that it is capable of receiving information in both digital and analog form. The Collector itself is basically a digital device; however, as part of the input circuits to the computer, we have included analog-to-digital conversion components. This enables us to be much more flexible in the types of inputs that can be used and in the type of information that can be obtained.

In order to establish the relative advantages and disadvantages of the Recorder and Data Collector methods over the traditional micromotion techniques, let us first attempt to specify the desirable characteristics of any research method used to determine elemental time values in the range of 1/28th of a second to 4 seconds. These, in my opinion, would be as follows:

1. The beginning and end points of the element under study should be easy to determine and to define.
2. It should be relatively easy and inexpensive to obtain representative sample sizes, not only in the laboratory but also in actual production operations.
3. The method of data recording should be capable of measuring information in very small intervals of time as compared to the total time of the element under study.
4. The data recording equipment should not have any constant error (bias).
5. The recording method should have as little effect as possible on the operator while the data is being recorded.
6. The process of reducing the data should be as free of error as possible.
7. The set-up of equipment should be fast and relatively easy.
8. As many as possible of the variables that

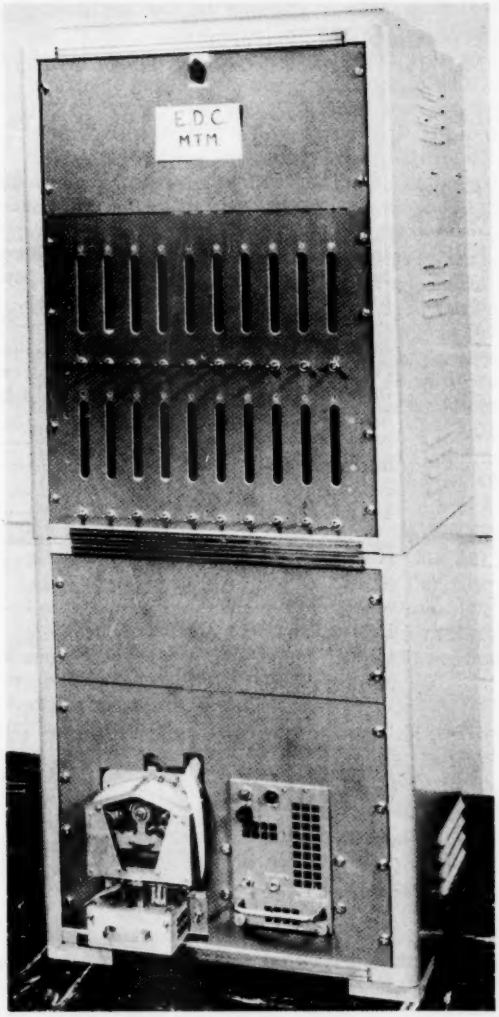

Fig. 3

effect the element under study should be capable of measurement.

9. The equipment should be of reasonable cost.

The following table is an attempt to compare the three methods according to the criteria just listed.

RELATIVE MERITS OF THE DIFFERENT METHODS

Evaluation Criteria	Micromotion Techniques	Graphical Recorder	Electronic Data Collector
Determination of Beginning and End Points	Difficult - Occurs frequently between frames.	Easy - Usually determined by sharp changes in curves.	Easy - Points are programmed into computer.
Ease of Obtaining Representative Sample Sizes	Difficult - Usually requires large amounts of film.	Fairly Difficult - Usually requires large amounts of graph paper.	Easy - Data is reduced and punched on paper tape.
Accuracy of Recording Technique	Poor - Average error is a frame which is 1/64 sec. or more (1/2 frame at beginning plus 1/2 frame at end).	Good - Error due to response time of equipment: 1/1000 sec. or less.	Excellent - Dependent upon Oscillator design - 1/28,000 sec. or less.
Equipment Error (Bias)	Excellent - If synchronous motor camera is used, error is predictable, but negligible.	Excellent - No error.	Excellent - Negligible error in well designed system.
Effect on Operator	Poor - Picture taking affects operator performance. Accommodation not usually possible.	Good - Wires, transducers can be positioned. Operator has time to accommodate before data is taken.	Good - Same comments as Recorder except computer is capable of operating continuously over long periods without attention.
Data Reduction Errors	Poor - Hard to read large amounts without errors. Error checking very difficult.	Good - Data obtained from continuous graphs. Easy to recheck for errors.	Excellent - Only possible sources are where operator interrupts cycle, or performs elements out of sequence.
Set Up	Easy - Use of cameras is well known.	Harder - Ingenuity is required to locate transducers and contact switches	Harder - Same as Recorder.
Variables That Can Be Measured	Limited - Time and distance can be measured.	Less Limited - Time, forces, acceleration and in certain cases position can be determined. Simultaneous motions can be determined.	Less Limited - Time, forces, acceleration and position in space can be determined with the help of a computer.
Cost	$300-$2400 depending on lenses and camera.	$4000-$8000 depending on the number of amplifiers.	$8000-$10,000 (to reproduce Collector).

This table in one sense represents an incomplete picture because it gives the impression that one technique has to be chosen, and all of the work done with it. Actually the use of all three techniques helps to obtain the best understanding. Motion pictures are used to provide historical records of the operation under observation; the Recorder method is used as an aid in setting up the instrumentation for the Data Collector, and the Collector is used to collect and reduce the data for final analysis.

One of the most important advantages of the use of the Data Collector in this type of research is the relative ease and speed with which one can obtain large amounts of information on a particular element. This characteristic will enable us to use much more sophisticated statistical techniques in our analysis. We have determined, that the man-hours to do research, at least in one particular instance, could have been reduced from approximately 5-man-months to less than 1-man-month if we had had the Data Collector available. In addition, we would have had much more information, and the data would have been in a more complete and accurate form.

OTHER POTENTIAL USES OF THE NEW METHODS

As mentioned previously, the Electronic Data Collector is portable and is capable of operating from any 110 volt A.C. line for long periods of time. In addition, the Collector can be reduced to the size of a large suitcase by using transistors in its construction. This would increase the portability of the Collector and also make it less susceptible to damage. Although we have primarily developed the Collector for use in the determination of elemental times, we feel that the following related work measurement areas will also benefit by its application.

1. Fatigue studies. The Collector is capable of recording cycle times either continuously or at a specified sampling rate over long periods of time; therefore it could be used to measure the trends in the length of cycle time.
2. Machine interference studies. The Collector can be programmed so that it would record the times when two or more machines are idle at the same time. In the situation where one operator is operating more than one machine, the Collector could serve as a tool for determining the proper allowances to be applied to standards for the interference time.
3. More consistent rating methods. As we all know, rating is one of the biggest sources of error in the work measurement system. With a collection instrument such as this, it would be possible to collect large numbers of elements and compare the ratings given for a cycle with the variation in the elemental times within the cycle. In this way, one should be able to correlate those elements which most significantly affect the rating given by the analyst. Once this is determined, the concept of normal time could be related to the length of certain elements within the cycle.
4. The effects of learning on cycle times. The comments under fatigue studies, above, also apply here. Since the Collector can record cycle times over indefinite periods of time, one has a method of measuring the change in performance of operators while they are learning.

A number of the above items are of interest not only to those whose main interest is work measurement research but also to the practicing industrial engineer. Several industrial firms are considering duplicating the Data Collector because of its ability to record information directly from a production operation.

The Recorder method can also be used in all instances listed above, but in comparison with the Collector method, it has two drawbacks: the data has to be reduced manually, and the recorder must be attended during its entire operating time. This method, therefore, is of primary value in the initial stages of work where continuous descriptive information is needed. As previously mentioned, the area in which the Recorder method will be used most extensively is in work on simultaneous motions of body members where the multiple channels can be used to measure motions that are occurring simultaneously.

GENERAL I

MTM MOVES INTO OVERSEAS MILITARY OPERATIONS

BuSandA methods engineering specialist D. Markoff (left) and staff director CAPT C. K. Phillips review course curriculum.

Supply Corps officers with just a smattering of "methods engineering" experience will soon find themselves devoting more time to the subject and putting it to work to assist in easing the "budget gap." This development is the result of a recent BuSandA decision to accelerate and extend the "Methods Engineering Program" (MEP) to cover all BuSandA managed activities by the close of 1963.

The Methods Engineering Program has two long term goals. First, it strives to make Navy supply operations more efficient. That is: Improve methods used in selected administrative or paperwork operations and physical handling of material; to increase productivity; make better use of existing facilities; improve working conditions, and reduce fatigue. Its second goal is to provide a better yardstick or standard against which operations, effectiveness, staffing requirements, production control and costs can be measured more accurately.

There is more in the preceding sentence than first meets the eye. For those that read and didn't appreciate its full significance, a product of the Methods Engineering Program will be a re-do of BuSandA's work measurement portion of supply management reporting system to put it on an engineered base rather than an historical statistical one. Since operating funds are justified in part through the medium of work measurement, it becomes imperative that people at all levels understand the Program and recognize its importance to their well being fund-wise.

Until recently, only a handful of stateside activities have had full Methods Engineering Programs. Over the past six years, the program has been implemented and is currently in operation at NSC Norfolk, NSD's Mechanicsburg and Philadelphia, Aviation Supply Office, Ship's Parts Control Center, and the Ordnance Supply

THE TURN TO

Office. Productivity increases achieved at these activities through implementation of MEP has been the primary basis for program expansion and acceleration.

Overseas supply centers and depots are to be included in MEP. The plan is to create Methods Engineering billets on the planning staffs of these activities. These billets will be filled by Supply Corps officers who will have the responsibility under the CO for implementing and supervising the Methods Engineering Program on a continuing basis.

How will the overseas program work?

Selected Supply Corps officers will be trained to fill the new Methods Engineering billets. Training will be comprehensive and will include seven weeks of classroom training at field activities in ConUS. The course has been designed to provide the student officer with a thorough knowledge of fundamental principles and concepts as well as the application of the latest techniques being employed today in the field of Methods Engineering. The classroom training will be followed by a period of guided application (on-the-job training). The guided application is designed to permit the officers to

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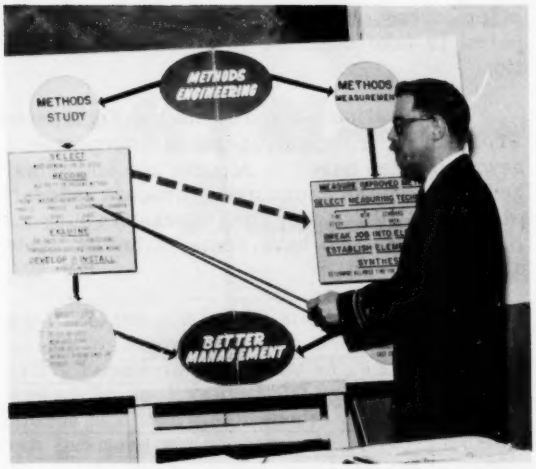


LTJG E. P. Dewey runs through some methods engineering fundamentals he will be teaching this summer at NSD Guam.

methods engineering

practice the theories learned in the classroom. Actual studies on operations being performed at the activity will be made under the guidance of a qualified BuSandA Methods Engineer. This period will aid the student officer in bridging the gap between theoretical study and practical application.

The officer training period can be expected to cover a minimum of six months. At its conclusion, the officer will be assigned to an overseas supply activity designated for Methods Engineering implementation. There, he will be expected to indoctrinate activity personnel; select analysts to conduct the program; train those selected; guide them in applying the techniques; and supervise the program on a continuing basis.

The Methods Engineering Program reflects current Department of Defense, Bureau of budget and Navy efforts to streamline operations and improve efficiency necessary to attain optimum effectiveness. Methods Engineering is a scientific approach to work study involving numerous techniques which encompass the areas of Methods Study and Methods Measurement.

• Methods Study is the systematic recording, analysis and critical examination of existing and proposed ways of doing work and the development and application of easier and more effective methods.

• Methods Measurement is the application of techniques designed to establish the work content of a specified task by determining the time required for carrying it out at a defined standard of performance by a qualified worker.

BuSandA started what is now called Methods Engineering back in 1954. It came after an experimental project had proved conclusively that the techniques previously applied only to industrial-type operations could be applied with equal success to paperwork and all other supply functions (warehousing, packing, preservation, EAM, technical, traffic, etc.).

The program then was known as "Engineered Time Standards" but was changed later to reflect the broader aspects of Methods Study and Measurement rather than only the one facet of Methods Engineering.

The experimental project's first objective was to determine whether or not the capacity of the Supply System could be measured. Up to that time, using historical data (the only measurement system permitted by Congress), management knew only what had been accomplished in a given period, not what could have been accomplished.

In 1959, an evaluation of the program and its potential benefits was conducted in view of constantly reduced budgets. This examination led to revision in its scope and objectives and also to a directive which resulted in the program being extended to NSD, OSO and SPCC, Mechanicsburg, and NSD Philadelphia.

Methods Engineering at these activities as well as other installations where the program was started initially produced measurable results in 1960 and a projection of the benefits to Navy Supply led to the decision by the Chief, BuSandA to expand and accelerate the program to achieve optimum coverage in from 2 to 2-1/2 years.

Under the accelerated program for ConUS activities, the Electronics Supply Office and NSD Great Lakes are already underway with the first phase of program implementation (training of selected analysis) to be completed this month. The program was started 27 February in the New York area and includes NSC Bayonne, the Military Medical Supply Agency and NPO. The Philadelphia complex of ASO, NSD and MISA are presently scheduled for program acceleration

on 3 April. A training program will commence 10 April in Mechanicsburg to augment the present Methods Engineering staffs at SPCC and NSD.

One of the first officers to be selected for a new overseas Methods Engineering billet is LTJG E. P. Dewey, SC, USN, now the assistant to the planning officer and comptroller at NSD Mechanicsburg. He will be assigned to NSD Guam.

LTJG Dewey has already received his initial training at a course conducted at NSD Mechanicsburg late in 1958. Since 1959, he has supervised the ME Program at the depot. There remains only his qualifying to teach all phases of the program. It is expected that he will conclude his preparation early in the spring and be ready for transfer to Guam by July. There, his assignment under the CO will be to implement the program throughout the activity and guide it through the initial stages.

Later, when the analysts are sufficiently experienced, close guidance will not be necessary and LTJG Dewey can expect to be freed from much of the personal participation required during the early months of program installation. His job, then, will be as administrator, supervising its over-all conduct, scheduling the coverage, and maintaining necessary liaison with the CO, department and division chiefs and BuSandA representatives. Under present plans, LTJG Dewey's relief will be another officer similarly trained, who will be prepared to take over the program's administration.

Acceleration of the Methods Engineering Program is receiving genuine acceptance at new activities based on reports and enthusiasm generated by the commanding officers and staffs of ASO, SPCC, OSO, NSD Mechanicsburg and NSC Norfolk, who have come to better understand and use it.

RADM J. M. Lyle, CO, ASO, wrote, "I was more than pleased at the re-emphasis you are putting on MEP. As you know, we were the first SDCP to put in an ETS operation and we have been enthusiastic about its growth and accomplishments. . . . I continue to be a strong supporter of MEP. I have seen the concrete results and I am convinced that it is the only program available to us which gives the supervisor a positive evaluation of his subordinates' productivity."

Navy supply is looking to its Methods Engineering Program to provide better ways of doing things. Through Methods Study and Methods Measurement the people of Navy Supply will be devising and using the better ways. Results will be more feasibility, sounder analysis of what can be done, and better operations. The Director of BuSandA's Management Engineering Office, CAPT C. K. Phillips, SC, USN, is already receiving requests from volunteers for Methods Engineering billets.

GENERAL II

MTM—

Problems and Solutions

by **Lloyd M. Griffin**

The need for MTM, or any other technique with which to establish standards and control costs, always has been of some concern to manufacturers. The interest is always greatest during periods of low profit and severe competition.

When such urgency for reducing costs subsides, there is a strong tendency to be satisfied with existing conditions. This situation always leads to trouble sooner or later due to our easy-going American way of life and normal human reaction to changes.

I will mention some of the problems which frequently are encountered during an MTM installation and explain how these problems usually get into the picture.

The problems you may have usually are overlooked because they have, from time to time, been creeping into your situation in the form of higher rates. In other words, your piece rates may be high enough to permit the operator to earn acceptable earnings in spite of the presence of these other problems.

Now, with MTM or any other technique, when you get your rates in line with normal work content of the job, these other problems must be corrected in order for the operator to reach her usual earnings level.

THREE TYPES OF PROBLEMS

What problems? Three general areas might be mentioned, but we will discuss only one area covering problems not directly related to the actual installation. The three are:

1. Problems which are part of the installation itself. These include MTM analyses, standard data, and its application, determining allowances, methods, and other technical problems.

2. Problems which are caused by installation. Opposition of operators to new rates and conditions, adequate supervision, supervisory opposition, methods training, etc.

3. Problems which relate to good operation of a manufacturing plant and which should be recognized and solved regardless whether you use MTM or even if you have no incentive system.

These problems, if not properly handled, will give you trouble at any time, but will prove fatal to a good standards installation. It is this group of troubles I want to discuss.

They are grouped under three headings: (1) operating policies and procedures; (2) garment and material specifications; (3) scheduling and production control. The order does not necessarily indicate their importance.

Too many times, management has let incentive systems run away with themselves and completely deteriorate due to so-called good times and high profits.

It has used unqualified, inexperienced personnel to obtain time standards. It has cut or eliminated a sound industrial engineering department, disregarding the impact of long-term economy. It has failed to train supervision in incentive administration, and perhaps bargained away the basic rights of management.

I can't stress too strongly the need for competent personnel to keep these problems out of your plant.

OPERATING POLICIES, PROCEDURES

Now to discuss what I mean by operating policies and procedures. First, we should set up these policies and put them in writing. They would be available to supervisors and operators. When they are available and written, it's unnecessary to make the same decision more

Reprinted by permission from Feb.-March 1961 issue of Femme Lines.

than once and certainly give consistency in application.

These policies would include the handling of payroll, so far as it concerned the operators' and supervisors' part in the procedure. They would define delay time and cover how it is to be handled and the time is to be paid.

They would explain how to handle substandard materials if delivered to the operator. They would include such items as starting time, rest periods, machine cleanup periods, quitting time, and other items dealing with ordinary daily discipline in a well-organized plant.

These policies and procedures should contain the company's position on activities which affect the day-to-day operating procedure and should contain fairly detailed instructions on handling any non-standard conditions.

Just having these policies and procedures in writing is not enough. They must be understood and followed. When in use this way, the result is a group of people who start on time and who work during the regular work period. When a non-standard condition occurs, it is recognized immediately and handled promptly. It also enables the supervisor to properly compensate the affected operator.

In such an atmosphere, the application of a proper incentive rate is not difficult because people are in the habit of working throughout the entire day. Also, the supervisor will recognize and take steps to correct non-standard conditions which arise.

Contrast this condition with one where policies and procedures are not set up and operating. Delays are allowed to continue without proper compensation to the operator. Rest periods often are prolonged and sub-standard materials are handled by the operators without extra compensation.

If the operator's wage is to remain at a fair level under these conditions, the rate must be high enough to cover such conditions. During periods of good materials, the operator usually limits production to conceal the looseness of the rate. Now, can you imagine the uproar if a proper rate is established without correcting the poor conditions?

CHECK GARMENT SPECS

The second group of problems or potential troubles may be listed as Garment Specifications, but would include specifications for raw materials and equipment.

Most of us would expect to find the measurements on various styles and sizes of garments correlated so that a medium size in one style is the same as the medium size in a similar style. Sometimes, we find that measurements between styles actually vary for no apparent reason. With all measurements, we should have a definite tolerance beyond which the garment is rejected for quality.

In the garment industry, we must have specifications for machine speed and stitches required per inch of seam. Stitches are important for appearance and seam strength. When an area stitched must be stretched to get the garment on, the stitch must have surplus elasticity to prevent breaking.

As most of you know, operators always are trying to get fewer stitches to increase speed so stitches per inch must be constantly watched if the proper number is to be maintained.

What difference does this make to the MTM analyst if the measurements, stitches, and machine speeds are correct?

In the MTM analysis, actual machine time is calculated. The time depends on three factors: (1) the stitches of seam sewn; (2) the stitches per inch of seam; and (3) the revolutions per minute for machine speed.

It should be clear that if a standard time is to be determined for sewing, we should have, and follow, specifications on length to be sewn, stitches per inch, and machine speed.

If our specifications are ever so good, but not followed, we may be paying for quality we are not getting. If rates are based on a specification which is not followed, performance on the rates may be erratic, and the inconsistent performance often is blamed on the rates.

WATCH PATTERN DESIGNS

Another area worthy of attention is that of pattern design. This can cause untold trouble in your sewing room.

Consideration should be given to the radius of curves for more efficient sewing without harming the design. Ratios between initial length of material and finished elastic, or shirring, may be adjusted to obtain a constant ratio from style to style and size to size. This will avoid much adjusting of machines and increase the chances of obtaining uniform quality.

Seam allowances should be consistent and parts to be joined need to be of proper length

to avoid irregular and difficult handling. All of these items affect the total time required to sew.

Failure to give the necessary attention to these details may explain erratic performance from style to style and may explain why some styles are considered more difficult to sew.

BUY THE RIGHT MATERIALS

Materials used are of utmost importance on sewing machines. Many companies take little care in the purchase of the right materials for their needs. I refer here to such items as elastic with the proper needle gauge and width for needle line; labels properly cut, folded and boxed; and labels of correct size, folded, if used on automatic machines.

Are the threads purchased correct for the quality needed and machine used? Can the cloth be purchased in a better way for handling? Are materials for trims purchased in the best way to use, or must they be rehandled? And are these conditions consistent from one shipment to another?

All of these things, and I am sure you can think of others, affect the method and time required to sew a garment or any other sewed product. If we set our rate based on a specific method, then the operator should follow that method for best results. If we allow interference, which makes it impossible for her to operate as we prescribe, our new rates just won't work as they should.

The last of the problems for this discussion is that of scheduling and production control.

SCHEDULING, PRODUCTION CONTROL

It is well known that the average workman resists changes and the sewing plant is well toward the top for changes. There are several ways in which production control can create problems related to an incentive system.

Most sewing plants operate on several types of cloth and these usually require some form of machine adjustment. When frequent machine adjustments are made, the problem of allowances is increased. There is a tendency to include too much in the allowance and not attempt improvements in conditions.

Sewing work requires a great deal of coordination, dexterity, and skill. To turn out satisfactory work at an average pace, it requires practice opportunity and this isn't possible with constant changes due to short runs.

There have been questions on the effects of changes from one material to another. Where to draw the line on assistance to the operator when changed from her normal work to other work has always been a problem.

Short runs also cause lower earnings, and increase pressure to remove operations on short runs from the incentive system. The quality of work performed can't be at its best without repeated performance over a reasonable period.

Operator morale is almost always lower when too frequent changes are given to which she must adjust. She develops a habit (commonly called muscle memory) which eases the mental effort and fatigue of the job. Short runs increase pressure to raise rates and cause more problems of special allowances.

SUMMARY AND CONCLUSION

To summarize: 1. You can't expect maximum benefits from any incentive system unless your company has clearly defined policies and procedures in writing. There should be definite instructions on how they are to be used. These policies and procedures should be understood by all supervision and employees.

2. Garment specifications must be worked out to cover the problems of manufacturing without adversely affecting design. All standard measurements with their tolerances must be in writing and available to all supervision and operators involved with their use.

3. Scheduling and production control should be in the hands of someone with knowledge of manufacturing problems. The need for repetitive work to obtain efficiency should be followed as much as sales policy and inventory control will permit.

To conclude, otherwise good standards installations sometimes fail to achieve expected results because these seemingly unimportant problems are not corrected.

APPLICATION I

"ASSEMBLY LINE BALANCING WITH MTM - MANUALLY AND BY COMPUTER"

by

Harold Crow

The Maytag Company

My presentation today will discuss three phases of Line Balancing:

I. The Conditions of the Problem.
II. The Approaches to the Problem.
III. The Solutions to the Problem.

PHASE I. THE CONDITIONS OF THE PROBLEM.

The first set of slides will illustrate the plant facilities at Newton.

1. The first slide is Plant I. You will notice the multi-story construction of the older buildings nearby the smokestack, and the single-story construction in the foreground. This newer building was built during the Korean war period and tank track parts were built here.

2. Plant II was built in 1949 with the original plan of capacity of 500 units per day. With movement of some support departments to Plant I, and adding capacity in Sheet Metal, Plating, Porcelain and Assembly areas, in addition to some 15 miles of overhead conveyor, the present capacity is approximately 3000 units per day. At this plant we assemble the automatic washers and dryers.

You will note the warehouse to the right of the picture, which is undergoing new construction which will add about 50 per cent capacity.

3. This is a view of the new Headquarters Building located adjacent to Plant I. Industrial Engineering is located on the ground floor of this building, and is in a large open area adjacent to Tool, Methods, Factory, and Construction Engineering departments. Engineering services for the Manufacturing Division are thus centralized for effective communications.

4. This is a view of our present 650 room located in the second floor of the new Headquarters building, and the RAMAC storage is located in the background to the right of the slide. The tape and RAMAC were installed earlier this year to supplement the basic 650 which we have had since early 1958.

5. MODEL "N" The wringer washing machine has been and still is an important item in our manufacturing volume.

6. We selected the Wringer Line at Plant I for our first trial of charting work elements for assembly line balancing with a computer. You will note that this line is a belt-type conveyor with individual fixtures for assembly. The operators are free to move most of the length of the line and physical restrictions are limited to stocking up some parts. The fixtures on the conveyor allow the assembly to be worked on in several positions.

7. The second line which was selected for trial balancing was the Finish Line. Note that the assembly is suspended by a chain conveyor and that the hangers serve a double purpose in that they are also used for painting the finished parts.

8. The next slide shows the point in the line at pressing the tub inside the skirt. This equipment creates a physical limitation in that some elements must be performed either before or after this point.

9. The finished machine is, of course, inspected thoroughly and any rejects are sidetracked to a boneyard rework area for correction before crating.

10. The Automatic assembly facilities at Plant II are of course more modern and you will notice the power-and-free system of individual carriers. The significance of individual carriers is that machines do not need to be handled in and out of the repair area.

The parts which you see are base frames which have been delivered from the Paint Dept.

Applications I thru VI are reprinted by permission from the 1960 MTM Seminar sponsored by the A. J. Kaerney Co.

by the Prime delivery conveyor in the background. The sub-assembly work is performed and the line operator removes them from the roller conveyor and places them on the individual assembly carriers.

11. You will notice the wide flexibility which is permitted in these individual carriers. Automatic washers cannot only be turned on their sides as shown in this view, but also the full 360° in a horizontal plane.

12. This point shows the continuous test loop where all the machines are given functional tests 100%.

13. This view shows the basic construction of the Automatic Washer. There are approx. 500 parts to be assembled on each of two major Automatic assembly lines.

14. The work sheet in this slide represents the specifications for an individual work station in the Dryer assembly area. Some of you may recall a few years ago we presented a talk at this A. T. Kearney MTM Seminar concerning the value of preplanning assembly lines with MTM. We used MTM as a basic measurement tool in planning the entire layout for conveyor installation for our Dryer Assembly area. Industrial Engineering estimates, along with Methods Engineering layout requirements, were provided to conveyor companies which aided them in determining our physical requirements. We were able to do a better job of detailed specifications. Their bids were complete, with very few additions or later changes required.

The Maytag Company was better able to evaluate the different conveyor proposals submitted. We also felt that we were getting the lowest price because the specifications were exact, and the bidders did not have to include a cost factor for unknowns.

The next slide will demonstrate how the MTM results were applied in this situation.

15. This slide shows a summary of the first 6 stations of the Dryer assembly line and the following slide -

16. shows both the two-dimensional and three-dimensional layouts which were completed before the physical conveyor facilities were installed.

We have also found these layout facilities are useful in charting our precedence relationships and limitations in the bubble charting for line balancing.

17. This slide shows the results of the MTM planning at the first work station of the Dryer assembly line. Notice that dryer drums are delivered to the work station on the Porcelain Top-coat delivery line. The operator is working at the #1 station of the drum assembly loop.

18. Other delivery conveyors, of course, are involved in supporting the three assembly lines at Plant II. This conveyor is the prime paint delivery line at one of the Dryer down stations.

19. This slide shows the Top-coat paint delivery line at another down station. Notice the conveyors coming down from roof-top level. This indicates the value of maintaining the three-dimensional layout in our Methods Dept.

20. This view shows the Dryer Black line in the intermediate stage of assembly. These carriers may also be turned in different positions for convenience of the operator in assembly.

21. This slide shows the cabinet being put in position from the cabinet feeder line to the main line. You will notice the green cabinet next to the one being assembled. The variety of models in the assembly line includes 6 basic models in 4 colors. This, of course, creates plenty of problems for line balancing as well as Production Control scheduling.

22. This slide shows the assembly fixture for control panels which is mounted on a monorail feeder line conveyor. MTM played a part in designing the best location for the containers of small parts.

23. This character in this slide may be familiar to some of you. Jim is showing how the control panel is transferred from the feeder line to the main assembly line by an operator standing on a platform.

24. This slide shows the Dryer packaging unit which completes the final assembly after which the product is delivered by belt conveyor to the warehouse for storage and shipment.

25. The Combination assembly area is along the same line as automatic and Dryer, but is a smaller area. This view shows the operator assembling the final stage of the Control Panel previous to testing machine.

I might mention at this point that the cycle time of the Combination, because of low production is several times as great, and the

balancing of this assembly line presents entirely different problems from balancing some other lines to approximately one-half minute bottleneck time.

26. Another area which involves assembly line balancing concepts is in the old method for sub-assembly of our Automatic pumps. They are assembled right in the Macine Shop area and delivered as a completed unit to the Assembly Dept.

This view shows a small 4-man group working with assembly fixtures on a slat-type conveyor. They were paid on a single bottleneck time.

27. This slide shows the improved method where each operator assembles the pump unit completely under a "job enlargement" assembly concept. With no requirement of paying observation time below the bottleneck, and with quality related to the individual, this improvement has some other benefits in addition to the dollars cost reduction.

PHASE II. THE APPROACHES TO THE PROBLEM.

The approach to the problem is outlined in the following six exhibits:

1. A General Classification of Industrial Engineering Techniques.
2. Bubble Chart—Assemble Clothes.
3. Manual Balance Using Chart.
4. Bubble Charting Procedure.
5. Memorandum of Results.
6. Old and New Manual Method.

PHASE III. SOLUTIONS TO THE PROBLEM

We are looking for the expected results.

Repeating the basic objectives, our results will obviously minimize:

1. The elapsed time.
2. The per cent balance.
3. The engineering hours.
4. The paperwork required.
5. The optimum balance.

In order to arrive at these five basic objectives, we have experienced considerable change in our concepts.

O L D	N E W
#1 Elapsed Time	#1 Elapsed Time
In the area of Elapsed Time, the old concept was to spend three weeks for one level change from the time the production level was selected to the time the labor standard would be installed.	The new concept would be to trim the Elapsed Time to 1-2 weeks and to provide not only a balance for the selected level, but also a level above and below that figure.
#2 Per cent Balance	#2 Per cent Balance
A better per cent balance involved the old concept that 80% of bottleneck time was good enough for an individual work station or operator.	The new concept would strive for 95% balance or better.
#3 Minimum Engineering Hours	#3 Minimum Engineering Hours
A. Keep the same sequence and chop off your elements at different points to balance an individual operation.	A. A chart should be prepared to show all possible sequences and then elements selected in groups to build up to a bottleneck time.
B. We are often engaged in wishful thinking about standard data for assembly lines.	B. We have found that standardized elements rather than standard data with care in selection of break-off points will result in a self-contained work element which is usable for any level.
C. The idea of knowledge of the line in mind of the engineer familiar with the area is	

the only basic information from which to balance the line.

D. Previously we had no concept of the relative importance of different elements. All elements were considered necessary to complete the assembly.

E. Originally, we dealt with very small regular elements on 100% of the parts and other irregular elements determined on a frequency basis for occasional work and stock-up.

#4 Paperwork Required

A. We have kept our element time source records by job or operation.

B. We formerly prepared spread sheets listing all elements and selected those elements to be used in various columns of the sheet.

C. Element coding has always been a problem to reflect all the variables that go with an element into one single code system.

D. Individual descriptions were previously very brief and the method was not always clear.

E. Typewritten ditto standards have caused us a lot of last minute typing load for our clerks.

#5 Optimum Balance

This change is significant in that rather than a single chosen level, we can select an optimum within an acceptable range higher or lower.

In other words, run a few more machines with the same number of operators, or

C. The precedence or bubble chart of the natural and possible sequence of assembly elements transfers the engineers knowledge into a document for analysis and enables the data to be processed by two computers.

D. Now the classification of elements into "Must Do," "Can Do," and "Might Do" elements based on the geographic zone in which this element may be performed provides opportunity for closer selection of the proper work elements.

E. Now we have larger work packages including not only several regular elements, but also related irregular elements. These are necessarily brought together into a practical work package quantity.

#4 Paperwork Required

A. We now keep our records in over all element index book filed by element number.

B. Now we rebalance from a cover sheet or IBM element cards.

C. With Bubble Charting, the chart itself takes care of most of the variables as to how and when an element can be performed.

D. An MTM description gives you an opportunity to tie down the method.

E. Printed IBM sheets can be produced at the rate of at least 150 lines per minute.

run a few less machines with less operators.

CONCLUSION

We recognize that we do not yet have the best approach but we are convinced that constantly improving our concepts and supplying new techniques will help us to obtain the lowest possible cost for assembly.

EXHIBIT 1

A GENERAL CLASSIFICATION OF INDUSTRIAL ENGINEERING TECHNIQUES

A. Mathematical Approaches & Techniques:

1. Statistics.

2. Quality Control.

3. Operations Research.

   a. Mathematical Programming.
      (1) Linear Programming.
      (2) Non-Linear Programming.

   b. Systems Simulation.
      (1) Probability & Mathematical Models
      (2) Queing Theory (Waiting Lines).
      (3) Monte Carlo Technique (Roulette Wheel Sampling).
      (4) Theory of Games (2 person Games & Others).
      (5) System of Simultaneous Equations.

   c. Complex Scheduling
      (1) PERT (for Polaris Missile).
      (2) Job Scheduling (for maintenance).
      (3) Bubble Charts (for Line Balancing).
      (4) Graphical Chart of Schedule or Program.

   d. Miscellaneous.
      (1) Information Theory.
      (2) Symbolic Logic.
      (3) Use of Computers
      (4) Optimization of Time or Cost.

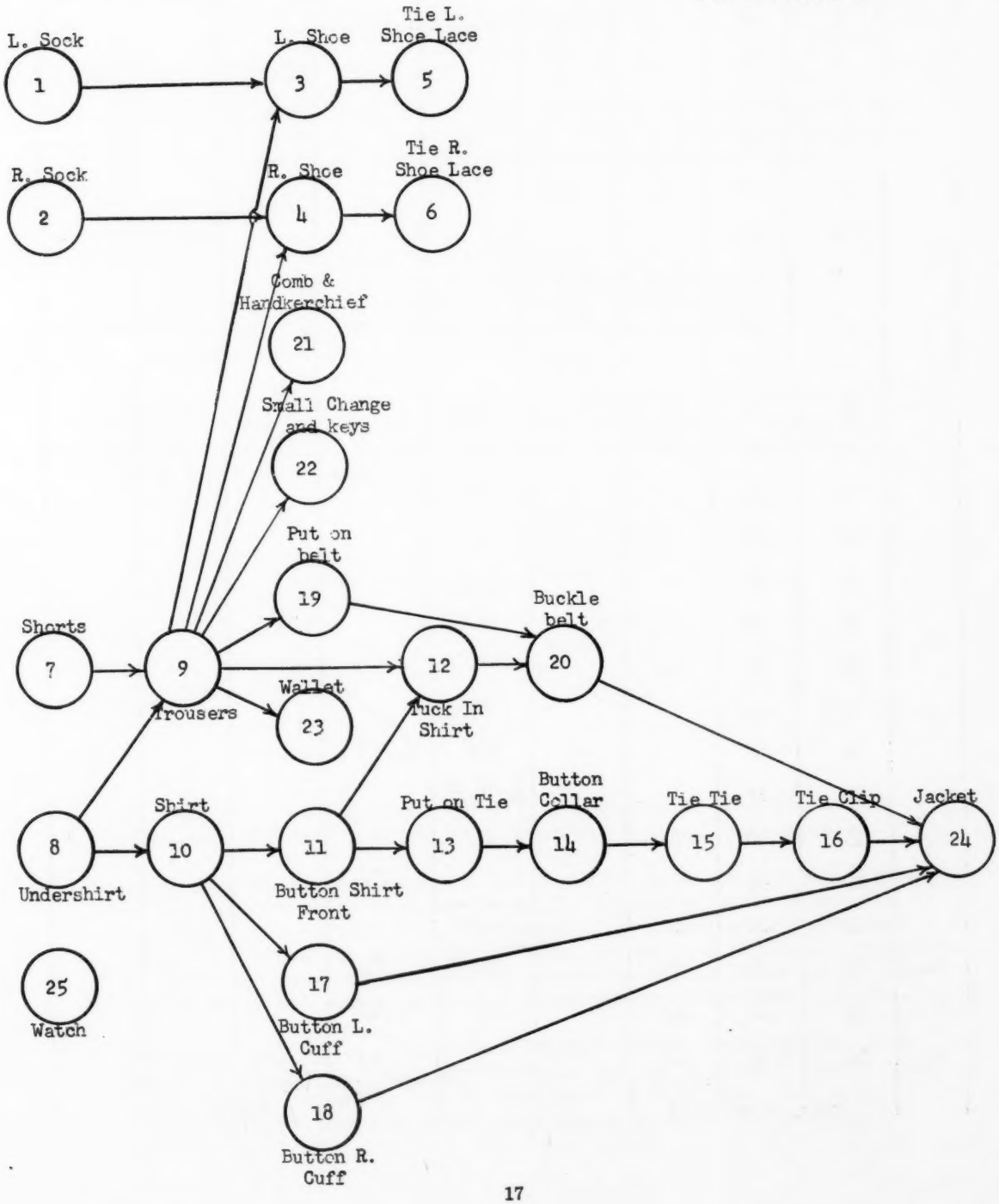
B. Other Work Tools of Industrial Engineering.

1. Motion Time Study.
2. Wage Incentives.
3. Work Simplification.
4. Flow Process Charts.
5. Film Analysis.
6. Multiple Activity Charts.
7. Plant Layout.
8. Work Sampling.
9. Measured Daywork.
10. Predetermined Times.
11. Budget Expense Reduction.
12. Production Control.
13. Inventory Control.
14. Data Processing.
15. Job Evaluation.
16. Standard Data.
17. Value Analysis.
18. Work Design.

EXHIBIT 2

BUBBLE CHART - ASSEMBLE CLOTHES

BUBBLE CHART
Assemble Clothes



APPLICATION I

MANUAL BALANCING WORKSHEET - ASSEMBLE CLOTHES EXHIBIT 3

BOTTLENECK 1.05 MIN.

Column Number	Element Number	Time Min.	Sum of Times	Cumulative Time					
				Oper I	Oper II	Oper III	Oper IV	Oper V	Oper VI
1	1	.09							
	2	.09							
	7	.10							
	8	.11							
	25	.05	.44	.44					
2	9	..22							
	10	.11	.33	.77					
3	3	.10		.87					
	4	.10		.97					
	21	.06			.06				
	22	.05			.11				
	19	.26			.37				
	23	.08		(1.05)					
	11	.19		100%	.56				
	17	.04			.60				
	18	.04	.92		.64				
4	5	.15			.79				
	6	.15			~~.94~~	.15			
	12	.12			~~1.06~~ .91				
	13	.10	.52		1.01				
5	20	.06				.21			
	14	.04	.10		(1.05)				
6	15	.55	.55		100%	.76			
7	16	.14	.14			.90			
8	24	.15	.15			(1.05)			
						100%			
	Total Time		3.15						

EXHIBIT 4

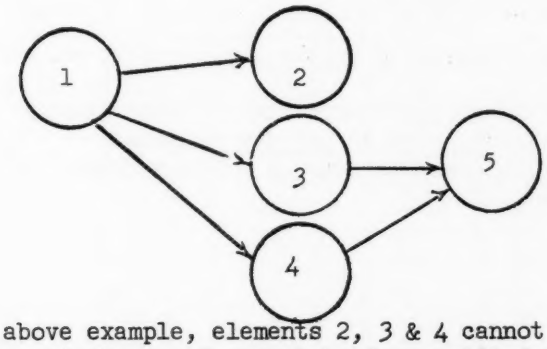
BUBBLE CHARTING PROCEDURE

I. Fundamental Concepts:

A. Elements (or work packages) as used in bubble charting refer to one unit of work performed by an operator. Each element must include the following elements as necessary for performance of the job:

1. Pick up and use.
2. Aside.
3. Walk or turn to bench to obtain parts.
4. Irregular elements, such as gage, adjust, or stock up if necessary to be done by operator performing job.
5. Any other TS or MTM elements which must be done by the same operator.

B. Bubbles - Each Element is shown as one bubble on the precedence chart. Arrows leading to a bubble from another bubble indicate such elements cannot be performed until the element from which the arrow is drawn is complete.



In the above example, elements 2, 3 & 4 cannot be done until 1 is complete. Similarly, 5 cannot be done until 3 & 4 are completed.

C. Zones - Assembly lines must be divided into zones to indicate areas of the line in which work may be done. Physical restrictions of the line, such as position of conveyor (high, low, etc.), permanent feeder conveyors or sub-assembly lines, as well as physical limitations of operators (such as man wearing gloves to handle large parts cannot handle small set screw) will determine number & location of zones.

D. Can-dos & Must-dos - Each element within a zone is designated as a can-do or a must-do. Must-do elements must be performed within that zone. Can-do elements can be performed in that zone, but also appear in other zones in which they may alternately be performed.

II. Restrictions:

A. Maximum number of zones 99
B. Maximum number of can-dos 95
C. Maximum number of elements per zone (can-dos plus must-dos) 50
D. Maximum number of precedence elements for any one element 12
However, if any more precedence relationships exist, a "dummy" job with an execution time of zero may be inserted.

E. Can-do elements become must-do elements in the last zone in which they appear. If this is not practical such as with sub-assemblies which could be done outside of the line, a dummy zone may be set up following the last zone in the line to simulate the sub-assembly area.

III. Machine Program:

A. No operator will be assigned work in more than one zone.
B. No operator's work will exceed the bottleneck time.
C. Each operator in a zone will be assigned at least one must-do element (& as many more as possible) before being assigned any can-do elements.

D. The job-sequencing indicated on the bubble chart will be maintained.
E. No operator will be assigned more than 24 operations, (12 must-dos maximum, plus 12 can-dos maximum).
F. Subject to the above restrictions, a minimum number of operators is used.

EXHIBIT 5

INDUSTRIAL ENGINEERING DEPARTMENT

June 20, 1960

To: Mr. J. F. Biggane (Mgr. I.E. Dept.)
cc/ Mr. R. L. Burdick (Supvr. Incentives)
Mr. C. W. Creagan (Supvr. W.S. & Exp. Red.)
Mr. H. L. Crow (Group Leader Exp. Red.)
Mr. R. Johnson (Group Leader Incentives)
Mr. R. Haugan (Ind. Eng. Assembly)
Mr. A. Anderson (Mgr. Data Processing)

SUBJECT: Status Automatic Line Balancing Meeting Held 6-17-60.

The above meeting was held to review the current status of line balancing with IBM equipment and to make assignments of additional work.

A. PRESENT STATUS:

1. Conventional wringer line as been diagrammed and coded for rebalancing, using the IBM Computer program which uses the bubble chart technique to show precedence of elements. Results of a trial run of several levels on this line were as follows:

RECAP OF INDIVIDUAL JOB BALANCES FOR WRINGER LINE

MAN NUMBER	LEVEL 1200	1000	800	675	600
1	96.8*	94.2*	72.5*	63.7*	56.8*
2	95.1	94.7	93.3	99.1	98.4
3	97.3	95.7	98.6	100.0	98.3
4	99.2	99.5	87.3	97.3	98.6
5	93.1	90.6	90.7	98.9	96.2
6	81.4	100.0	87.7	96.0	72.0
7	98.6	92.9	98.0	28.8	
8	98.4	93.6	33.0		
9	91.3	96.4			
10	92.3				
11	63.1				
AVERAGE BALANCE	91.5	95.3	82.9	83.4	86.7

*Note: Limit of 12 elements per man.

2. R. Haugan has used IBM element cards to manually balance the Combination line. A fifteen (15) page P. E. listing the element titles was typed automatically on the IBM 407 printer in approx. 5 minutes.

EXHIBIT 6

ASSEMBLY LINE BALANCING

Old Method Manual	New Method Manual
1. Preparing P.E.	1. Preparing P.E.
a. Engineer selects elements from index book or cover sheet and assigns to operator by element number.	a. Engineer selects elements from index book or cover sheet and assigns to operator by element number. (1) Clerk sorts IBM cards into groups. (2) Eng. checks for accuracy & sends to Data Processing.
b. Clerk types P.E. from element numbers.	b. Data Processing prints P.E.
c. Foreman reviews balance with engineer	c. Foreman reviews balance with engineer.
d. Clerk duplicates P.E. and distributes.	d. Up to 5 or 6 copies available.
e. Foreman makes revision with engineer and agrees to sequence for standard.	e. Foreman makes revision with engineer and agrees to sequence for standard.
2. Preparing Labor Standard (Cover sheet)	2. Preparing Labor Standard (Cover sheet)
a. Clerk types from revised P.E. cover sheet.	a. Engineer sorts IBM cards as required into groups. (1) Send to Data Processing (2) Data Processing prints labor standard cover sheet.
b. Engineer reviews methods descriptions for accuracy.	b. Engineer reviews method description for accuracy.
c. Clerk duplicates and distributes.	c. Up to 5 or 6 copies available.
3. Prepare Individual Labor Standard	3. Prepare Individual Labor Standard
a. Clerk types individual descriptions from cover sheet codes and description in index book.	a. Engineer responsible for maintaining accurate description. (1) Send title cards to Data Processing. (2) Send corresponding description cards to Data Processing. (3) Data Processing matches description cards to title cards and prints individual labor standard.
b. Engineer reviews for accuracy and obtains approvals.	b. Engineer reviews for accuracy and obtains approvals.
c. Clerk duplicates and distributes.	c. Up to 5 or 6 copies available.
d. Shop may use to instruct operators.	d. Shop may use to instruct operators.

APPLICATION II

A SUPERVISOR'S EXPERIENCE IN INSTALLING MTM STANDARDS

by

Walter Bennett

Brunswick Corporation

My purpose in speaking to you this morning is to tell you of my experiences with an MTM installation at The Brunswick School Equipment Division in Kalamazoo. Here we converted from a time standards program, based on stop watch study, to an MTM basis of time measurement.

As General Foreman of the metals division, I was in a good position to work with the employees, the engineers, and the Union during the complete phase of the MTM standards installation. In order to better understand our position and our problems, it would be well for you to have a background of our particular situation at Kalamazoo.

We had standards in effect on similar operations at Muskegon before we moved to Kalamazoo. These standards were based primarily on time study observations. In the move to Kalamazoo, we were faced with several very pressing problems. One was that we had a relatively low base rate in the Kalamazoo area. This gave tremendous pressure to get workers earnings up as fast as possible and still maintain protection for proper standards administration. Because we would have the standard based on comparable operations at Muskegon, we initially set forth on a very fast standards application program, using time study. The use of this approach would satisfy management's second major problem of quickly establishing a high productivity level while maintaining adequate employee earnings to reduce labor turnover. This crash program in broad standards application did result, however, in certain inequities and earnings variations creeping into the standards system. We were left with certain standards which were apparently unattainable by certain employees; and at the same time, had other standards in effect which showed considerable variations for seemingly comparable jobs. A part of the problem at this time was the tremendous preoccupation of production supervision to get out the goods, rather than spend a great deal of time on the fine points of standards administration. At this stage, management began its preparation for an MTM installation.

My first brush with MTM was when all supervisors attended training classes to learn the fundamentals of MTM. In these classes the mechanics of MTM were thoroughly explained so that we would be in a better position to explain it to the employees. Concurrently with our training in MTM fundamentals, management sent selected representatives of the Union to Chicago to be trained in the application of MTM to the development of incentive standards. Concurrent with this program of training, our engineers who had previously been trained in the MTM techniques, were working with consulting engineers in developing the basic data for the installation.

The selection of our first job on which to apply MTM standards was considered most important. The job that we selected was one on which we have had a very difficult time in getting any production employees to consistently make their production standard. This operation we call capping. The time study elements that we had in effect on this job did not, because of the shortness of the cycle, adequately describe the precise method which had to be used. When the MTM standard was developed, the standard time value was very close to the original time study value against which we were unable to obtain satisfactory performance. However, in the detailed MTM analysis making up the time values, we were able to determine the precise motion pattern which had to be used to make the standard. This was a revelation on this particular job, because we were able to teach the workers elemental move by elemental move just what they had to do. Our problem was one of precise method; and on this job, MTM really earned its acceptance by our supervisors. From this point forward, our concern for the attainment of standard on the capping operation was a thing of the past. This first installation spelled out

for us the tremendous importance of the motion analysis advantage that MTM had over our conventional time study.

I have experienced no particular problem in gaining acceptance for MTM standards in my discussions with the people. We made it a practice before any group worked against MTM standards to bring them together and talk to them like "dutch uncles." We explained to them that our company is in a tough competitive market, and that we must do everything that we can to minimize our manufacturing costs. We explain that the MTM techniques which we are now using help us to develop the best method for every job. I have found it much simpler to explain to the employee that his standard is built up of basic movement values, which have been studied and accepted through hundreds of studies and actual work checks. They seem to be better able to comprehend this, rather than the conventional approach of a time value with a leveling percentage applied. I like to use the example of MTM being a composite of many studies, and on this basis explain to the employee that this is a more fair way of determining a standard, rather than a 10 cycle study of a particular job under specific conditions.

Another important consideration we found in getting proper acceptance to an MTM installation was to be very careful of the man you select to initially work on a new MTM job. Before I put a man on the job, I will try to get across to the individual, whom I have preselected as a cooperative type of person, how important it is that we make this system work. All we expect, I tell him, is to give this a real honest try. We may butter him up considerably, but we have found this many times to be the only way to break some standards that may be resisted for any of many reasons.

Another example of applying MTM to some of our troublesome operations occurred on our traditional chair line. In this operation we had a single standard in effect for a range of chair chassis sizes. At Muskegon we had had a similar situation for a long time, and ended up with high earnings on the small chairs and low earnings on the large chairs. At long last the engineers at Muskegon developed two standards . . . one for a smaller group and one for the larger grouping. This was an improvement. Then we moved to Kalamazoo, and guess what . . . again they gave me a single standard on which I ran into a lot of the same old problems. When the engineers would be called out to check some of the chair sizes for variation in time, neither of us could pick out the difference; and yet, my production output varied quite widely. When MTM was applied to this job, it was like a light shining down from heaven. The various sizes of parts, with their corresponding length of movement and weight considerations, gave us the variation in standard between sizes we have been looking for all along. This illustrated to all of us one of the desirable features of MTM; its ability to reflect time variations in size and weight and show this variation in the series of standards developed.

At this point, I don't want to have you feel that the use of MTM is all a bed of roses. We have had problems in certain areas. One situation I would like to mention has to do with a forming and piercing operation on a back support tube. The engineers in this particular case went completely overboard in over-methodizing the job. If we could pre-select a man with three arms and four eyes, we may yet be able to make this particular standard work out. The problem here was that a method was established that would take a physical superman to perform. We ended up with many different men trying to act as acrobats and jugglers, but the operation resulted in a high scrap loss and only mediocre earnings attainment. An MTM re-evaluation of this operation with a small increase in total time, resulted in a standard which is still not perfect, but does eliminate high scrap potential and on which men can make reasonably good earnings. This certainly illustrated to us that any methods application by MTM or otherwise, must be within the normal learning cycle of a normal, qualified, incentive operator.

As is normal in any progressive organization, we have had to make changes. My supervisors and myself have found it considerably easier to explain changes to the factory employee when they were based originally on MTM. It is much simpler to show that distance, size of parts, complexities of dies and stops, etc., have changed when the original method was so precisely spelled out element for element.

If I could lay down any guide rules from my experience at Brunswick to help the installation of MTM standards, I would state the following:

a) Supervision must have a thorough understanding of MTM and its application. This not only is necessary from an employee explanation standpoint, but is extremely helpful in getting our supervisors to be much more methods conscious in all of the work we do.

b) The Union people must have, at the very least, a basic understanding of what MTM is all about to remove the mystery and suspicion of such a technique as far as is possible.

c) The first job on which MTM is applied should be one on which you are reasonably certain to show a good result.

d) The person whom you pick to perform against this first MTM standard should be one who has demonstrated in the past that he will give a good honest try to something new and different.

e) And last, but most important, is close follow up by supervision and the standards engineers to see that the people start off in the proper method, and continue at the job long enough to get over the hump and consistently make a satisfactory earning. No standard, no matter how perfect it may be, is not worth a plug nickel if the people running against it are not at least up to 100% performance.

I hope these brief remarks on my MTM experience at Brunswick may help in some small way, to make any contemplated MTM conversion in your plant a bit easier to install.

APPLICATION III

MAINTAINING MTM SYSTEMS THROUGH EFFECTIVE CONTROLS

by

Les Mickelson and Glen Ferrick

O'Cedar Division American Marietta Company

MR. MICHELSON

Our part in this program this morning is to talk about maintaining MTM systems effective controls. This will be handled very ably by Mr. Glen Ferrick. However, I think before we get into this part of the talk, I would like to tell you a little bit about the problems that we had in getting into an MTM program, and believe me, these were not small and they were not few in number. Our wage incentive program at O'Cedar prior to the MTM was an outmoded, outdated, ineffectual wage incentive program. We had a union shop which, my respects to the Union representatives here, made it doubly hard to make this transition.

As you may know, O'Cedar has been a household by-word for some past fifty years, and since 1952, has been a division of American Marietta Company. In the past few years, we have known, and undoubtedly many of you have felt the current profit squeeze. O'Cedar is no different. Management, in this respect, thought that we had been doing a good job, but, however, thought it could be done better and more efficiently, always looking for that last one-quarter cent or per cent of profit. The thing to do at this point then, was to seek out professional people to aid us in this problem.

Basically, this was our problem. We were plagued with high piece rates and inequalities that existed between labor grades. It was necessary to bring earnings more in line with job evaluation. We had controlled output, in some cases, and 200 per cent and in other cases as high as 250 per cent earnings. This, as you all know, is something that you cannot live with and still be competitive. We had competition from the South in the same markets that we competed in. We just could not pick up and move our plant to the South. It just behooved us to be more efficient and to do a better job when it came to control and to bring our manufacturing cost more in line. This, then, brought us to the point on what were we going to do.

A. T. Kearney provided the start through an MTM program. It then became our job to sell MTM to the Union and to the people. Gentlemen, let me say right here and now, that when you have people that have not been putting in an eight-hour day and making 200 per cent earnings and you are going to try to sell them on working for a change, for maybe 130 or 140 per cent earnings, believe me, it's tough. Well, at any rate, we decided that possibly the best way to do this would be to sell it through the Union at the negotiating table. How are we going to go about this? Well, there were a number of different ways that you could try to blunder through this thing. We have a pretty good Union. So we thought that we would give a little and probably make an offer of a higher hourly increase in exchange for a clause in the contract permitting us to re-evaluate all standards. Well, gentlemen, this worked. The Union was able to go back to their people and say that they had gotten something from management, which was a higher hourly rate, and we, in turn, had our foothold in the door so that we could begin our MTM program.

The next problem, which was just as great, was to build an engineering organization and to find a good chief industrial engineer. After much recruiting and interviewing we hired our chief industrial engineer and we have built the nucleous of the organization around him. Mr. Ferrick is well acquainted with MTM, and I believe, well acquainted with a number of you gentlemen. He has done a very fine job and he will point up what the controls are that we are using so that management can be shown how effective we are in our day-by-day job of carrying out the MTM program. We will show you how, through these controls, we have maintained our objectives; will indicate what our accomplishments have been over the year, and also what our future objectives are. I might just say, before I close this introduction, that since the installation of the MTM program, we have become much more efficient. I know this is a

catch-all phrase that doesn't mean anything unless it is backed up by facts, but we are now looking at labor more critically. No longer can a man just sit by and put in eight hours of time and collect 200% or 250%. We have professional people on the job. The program has given our management measuring sticks whereby they can cut down on the inefficiencies and take us to task when we do not do our job. We are in a better competitive position and our standard rates are certainly more steady and in line. Gentlemen, we would like now to go into the control portion of this presentation which will show that our MTM program has done a very wonderful job at O'Cedar.

MR. FERRICK

MTM has done a very good job for us in the year we have been using it. I think one of the best uses we have made of MTM has been in balancing our assembly lines with it, but, I won't spend any time on this subject because one of the speakers after me is going to talk on that subject.

With the use of MTM we have lowered the direct labor on every product in our line. These savings have ranged from 35 per cent to 60 per cent. Of course, not all of this saving can be attributed directly to the use of MTM. However a good portion of the method improvements can be traced back to the fact that MTM makes everyone methods conscious. We have had a good deal of improvement in our costs picture and we want to make sure we maintain what we have.

One of the major problems in a standards program is maintaining it correctly. One of the biggest problems is what we call "Creeping Methods Changes." There is where small differences creep into the standard through time; by speeding up R.P.M.; the number of revolutions per minute, or increasing the feed, etc. There are a good many other variables which always seem to become incorporated into the job unnoticed which result in an increase in productivity. One company, I believe it was General Electric, figured these changes loosened their standards by about 6 per cent per year.

So, on the basis of this it behooves us to obtain a very detailed and descriptive write up of the actual method being used at the time of the MTM study. This then is where we begin our standards maintenance and control program.

Slide Number 1 shows how MTM in itself gives us a detailed motion pattern which is not possible with stop watch studies. The form has been typed for clarity only. This is a standard MTM worksheet form. This form shows distances, classes of motion, pressures required, etc. for each hand. The write up should be as neat and accurate as possible because this is going to be the only figures you have to fall back on when it comes to weeding out these "creeping changes" at a later date.

For example, sometimes as a fixture wears, apply pressures are eliminated. In stop watch studies this is not always apparent.

Slide Number 2 shows our next step in the control function. This is our Standards and Methods Authority Sheet. This contains a detailed description of job, and a guarantee of the standard on this job as long as conditions as described on this standard form are same. Also, you will note that this specifies the Crew Size and the standard, both in hours per hundred but also in pieces per hour.

Slide Number 3 is the back side of the form shown on previous slide and show work place layout. We use a Polaroid camera to photograph the layout at time of study. It also shows the materials, equipment, quality required, safety and special comments. This form is typed in six copies. The original copy is signed by Industrial Engineer, reviewed and signed by Foreman, and approved by Production Manager. The distribution of these six copies is as follows:

1. The original is filed in Industrial Engineer's file.

2. One copy is protected by a glassene envelope and hung on machine or at the workplace for the operator's information.

3. One copy goes to the foreman for his file.

4. One copy goes to the Accounting Department.

5. One copy goes to the departmental timekeeper.

6. Product Development receives one copy for reference on labor costs for future designs.

Prior to installation of a standard, it is discussed with foreman and then the Production Manager. When approval is given, the foreman and the industrial engineer discuss changes in the method, disposition of excess people, new layout, etc., with the Union steward. After the steward has been informed, the foreman, steward and industrial engineer approach the operators and inform them of the changes to be made and when the standard will be installed.

After the standard has been installed, the next logical step is to monitor the standards on a day-to-day basis. We acccomplish this by the use of a Daily Labor Control Report. As illustrated in Slide Number 4 this report is made out by the timekeeper from the daily time cards. It shows:

Product and Operation Number
Operator Clock Number
A check to indicate if this job is an MTM standard
Actual hours worked
Earned hours
Make-up hours
Non-standard earned hours
The performance on each job
Non-rated hours for each department
Non-productive hours spent by production workers
Indirect hours

This form goes to Industrial Engineering Department, Production Manager and Department Foremen. As our production runs are generally several days or weeks in duration, we can analyze this form in the morning and we can check on any operation that shows up out of line, either high or low for the run of the previous day and take corrective action in just a matter of hours after the job starts.

From this Daily Labor Control Report we make out a Weekly Labor Control Report of all the departments on one sheet as shown in Slide Number 5. We do this by combining all the daily figures onto one form. This form goes to all the holders of the daily form, except one extra copy is sent to the Vice President of Factory Operations for his analysis. This form shows the per cent performance and coverage by departments, maintenance hours by department and the general summary for all departments combined.

We also chart each department in graph form on per cent performance and per cent coverage on a weekly basis. This is routed to the Production Manager and Vice President of Factory Operations and returned to Industrial Engineering Department. This, then, in brief is our procedure to control our new and growing MTM program and it has done a very successful job for us.

We also maintain a running report on each standard which is issued with MTM. We show the old standard, the new standard, the annual production, savings per operation annually and an accumulative savings to date. This report as shown in Slide Number 6, is issued periodically to keep top management informed as to what progress our new program is making and what total savings are being realized.

We have made, we think, a very substantial showing with MTM in the field of Direct Labor and now want to go into the field of Indirect Labor. We have, at present, an incentive program for our Shipping Department based on stop watch studies. This is one field we want to restudy with MTM. Along with this, we will be working on trying to improve the efficiency of our other indirect workers, such as material handling, maintenance, etc. We hope to make as much improvement in these areas when we install MTM as we have in the direct labor areas.

SLIDE #1

M - T - M

Page 1 of 1

Date 3-18-60

PRODUCT NO. 1804
DEPARTMENT NO. 09
OPERATION NO. 14
OPERATOR NO. --
ANALYST Glenn Ferrick

PROD. DESC. #4A & #9A Socket
DEPT. NAME Punch Press
OPER. DESC. Stake Clip to Socket
OPERATOR --
EQUIPMENT #19 Punch Press

LEFT HAND		MOTION LH	TMU	MOTION RH		RIGHT HAND
in box		RL1	11.8	M8C		Asy. to die
to socket		R16C	9.1	P1SSE		into die
			2.0	RL1		Release part
				EM		Press foot lever
				M1		10 strokes = 100 TMU
socket		G4A	19.8	R20C		to clip
				EM		release foot lever
secure	2	G2				
			9.1	G4B		clip
socket to clip		M16C	11.9	M22C	⅓	clip to socket
socket to clip	⅓	M16A	10.4	M22A	⅓	clip to L.H.
grasp clip		G3	2.8	G3	⅓	release clip
			2.0	R2A	⅓	to clip
release clip		G3	2.8	G3	⅓	grasp clip
		M1C	1.7	M1C	⅓	clip to socket
			2.8	G2	⅓	secure
		P1SSE	9.1	P1SSE		clip to end of socket
			5.6	G2		slide thumb
release		RL2	-			
thumb to clip		RFA	2.0			
		G5				
seat clip		AP1	16.2	AP1		seat clip
socket		RL1	2.0	G2		secure control
to part in die		R10A	8.7			
part		G1A	2.0			
pull & release		M5B	8.0			
			139.8			

APPLICATION III

SLIDE #2

STANDARD AND METHOD AUTHORITY
O-CEDAR DIVISION
AMERICAN MARIETTA COMPANY

Product Description #4A-9A Mop Sockets Product No. 1804
Operation Description Stake Spring Clip to Socket Oper. No. 14
Equipment #PP 19 Dept. Punch Press Dept No. 9

Element Number	METHODS DESCRIPTION
1.	Position assembly in die with right hand, trip foot pedal and at the same time reach to and grasp one socket with left hand. Reach to spring with Right Hand.
2.	Get socket towards Right Hand, pick up spring with Right Hand and get it towards Left Hand.
3.	Assemble spring to socket, first engage the spring lips to socket groove and then align hole to pin on socket.
4.	Transfer the socket assembly to Right Hand, with Left Hand flip out the finished unit from die and with Right Hand Position the assembly in die.

THIS STANDARD IS GUARANTEED as long as conditions remain as described on this and accompanying sheets. It will be cancelled immediately if there is an approved change in method, material, quality requirements, or equipment, and a revised standard compensating for the changes made will be issued as soon as practicable.

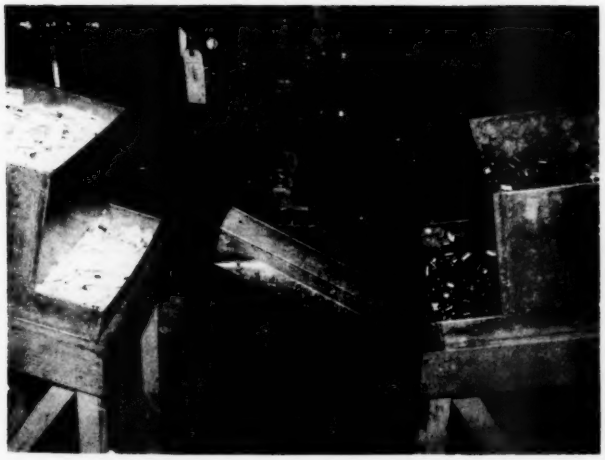
Std. Hrs/ C Pcs	.165
Crew Size	1
Pcs./hr.	606
Effective date	3-17-60
Superceeds	9-10-59

Prepared by:	Approved By:	Reviewed By:
Industrial Engineer	Plant Manager	Departmental Foreman

APPLICATION III

SLIDE #3

WORK PLACE LAYOUT, PARTS, TOOL, ETC.



ALLOWANCES: This standard contains allowances of 18 % for personal time, rest, minor unavoidable delays, and keeping work area clear, pickup dropped parts, etc. The employee must inform the foreman if an unavoidable delay extends beyond 6 minutes. The employee will receive credit for all foreman approved delays. (3% Additional allowance to cover extra clean up time permitted in this Department is included in this standard)

MATERIAL:

#4A - #9A Sockets, Spring Clips

EQUIPMENT, TOOLS, SPEED, FEEDS:

Punch Press #19

MATERIAL HANDLING:

Supplyman supplies sockets and springs to hoppers at work stations and removes cartons of finished units. Operator disposes finished units to chute.

QUALITY:

Spring should properly seat.

SAFETY:

Sheet metal guard in front of die.

REMARKS:

APPLICATION III

SLIDE #4

DAILY LABOR CONTROL REPORT

DATE DEPARTMENT SHIFT

CLOCK NO.	PROD NO.	OPER NO.	M T M	ACTUAL HOURS	NON STD EARNED HOURS	TOTAL EARNED HOURS	MAKE UP HOURS	% PERF	NON RATED HOURS	DIRECT NON PROD		IND. HOURS
										IDLE HOURS	OTHER	

CC: Mr. P. K. O'Connor
Mr. L. N. Mickelson

WEEKLY LABOR CONTROL REPORT
ALL DEPARTMENTS

Week Ending:

Side II

Dept.	Yarn Mop		Plastic			Shipping	Receiving	Misc. Maint.	All Depts.
Shift	1st.	2nd.	1st.	2nd.	3rd.				
1 - Total Actual Hours Worked 2+6+9+11+13									
2 - Actual Direct Rated Hours Worked									
3 - Actual Direct Earned Hours									
4 - Make Up Hours									
5 - % Perf. 3/2 x 100									
6 - Non Rated Prod. Hours									
7 - % Coverage $\frac{2}{2+6}$ x 100									
8 - Non Standard Earned Hours									
Direct Non Prod. Hours Worked By Productive Oper.									
9 - Idle									
10 - %									
11 - Misc.									
12 - %									
13 - Indirect Hours Worked									
14 - % Ind/Prod $\frac{13}{2+6}$ x 100									
15 - Maintenance Hours									
16 - Cost Perf. % $\frac{2\ 6}{1+4+8}$ x 100									

APPLICATION III

SLIDE #5

O-CEDAR
DIVISION OF AMERICAN-MARIETTA COMPANY
CALCULATION OF DIRECT LABOR SAVINGS
RELEASED STANDARDS

PROD. & OPER. NO.	PART AND OPERATION DESCRIPTION	DATE RELEASED	OLD STANDARD HRS/C	NEW STANDARD HRS/C	SAVINGS HRS/C	INCREASED COST HRS/C	ESTIMATED ANNUAL PRODUCTION DOZENS	PROJECTED SAVINGS $/YEAR	ACCUMULATED SAVINGS $/YEAR

APPLICATION IV

STANDARD DATA FOR DIE SETTING

by

Robert J. Ohlweiler

Victor Manufacturing & Gasket Company

Victor Manufacturing and Gasket Company is celebrating its fiftieth anniversary this year. Victor is the world's largest manufacturer of gaskets. Victor also manufactures oil seals for all applications.

We are presently in an extensive MTM program, converting all of our direct labor operations to MTM standard data. At the present time, we have about 60 to 65 per cent of our direct labor operations converted to MTM standard data. A very substantial portion of our equipment is punch press equipment. This brings me to my topic "Standard Data for Die Setting." In this talk, I intend to cover the following items:

1. Why we chose MTM in preference to stop watch studies.

2. The method we used in assembling this data.

3. The content of our die setting data.

4. A sample of the application of this data.

5. Some comments on the use of this data, including how we established our personal, rest, and delay allowances, and allowances for servicing presses previously set up.

Why Do We Use MTM in Preference to Stop Watch for Establishing Our Die Setting Data?

We used stop watch studies to set up standards in several departments. We found variations in the allowed time for existing elements in the same department. There were variations from one type of operation to another, even on the same size punch press. For example, in one department the standard for setting a blanking die was less than that for setting a closing die. This is not as it should be. Our MTM studies showed that the blanking die set up standard should be higher than the closing die standard. There are several additional elements in the blanking die set. For example, assembling the knockout plate on the blanking die. I would like to add that these stop watch studies were taken by competent well-qualified Time Study Engineers. I am sure that most of you have run into the same problems in setting up standard data from stop watch studies on long-cycle, nonrepetive work such as Die Setting. Another reason we use MTM in preference to the stop watch is that more information is available to show the affect of tooling equipment and method changes.

I would like to refer you now to Exhibit Number 1 which will illustrate the type of savings that can be found by developing better methods through the application of MTM. This is one small element of our Die Setting Standards.

Another condition we found was that each Die Setter was using his own tools and each Die Setter had different tools. If one Die Setter needed a 12 inch Box Wrench and did not have one, he would walk across the department and borrow a wrench from another Die Setter. Then, when the other Die Setter needed his tool, he would have to locate the first man in order to get his tool back. To eliminate this condition, we made a list of the tools needed for Die Setting; and the Company now provides a set of tools for each Die Setter. In this way, we have also standardized the type and size of wrenches used.

We found that actually all of the reasons for using MTM for production operations are basically the same reasons for using MTM for Die Setting operations. After all, Die Setting is mainly a manual operation.

The Method We Used in Establishing Standard Data for Die Setting

First we made a preliminary survey. The preliminary survey was made to determine the

punch press types and sizes that needed to be covered. We also checked the affect of different operations on the same type and size of punch press. Many studies were taken to obtain the normal breakdown of elements for data coverage. Through these studies, we found that 70 to 75 per cent of Die Setter's time spent in setting a die is either walking (with or without carrying weight) pushing a tool truck or die truck in the department, or turning nuts, bolts, screws with a tool or by hand. Remember these three points because I will show you a little later in a sample die set standard how many elements are actually covered by these three elements of work. We broke down our data into two categories:

1. Motion patterns that apply to any die set regardless of press size, type of die, or area. For example, it would take the same amount of time to assemble a 5/8 inch stud with a 12 point Box Wrench on a 103 Double Crank Punch Press in one department as it would on a Number 7A Verson Single Crank Punch Press in another department.

2. Motion patterns that apply to a specific type or size of punch press. Examples of these are: sliding the die from a die truck and aligning the die on the Bolster Plate. This would depend on whether or not the press was an upright or tilted press and other conditions characteristic of the specific type and size of punch press. Raising or lowering the ram, adjusting the ram for proper height, or running sample parts for inspection, are other examples of motion patterns that apply to a specific type or size of punch press.

The Content of Our Die Setting Data

We termed our data "Basic Motion Data." This data is set up in motion patterns. It may take several patterns to make up one time study element. Each motion pattern is numbered and/or lettered to code the variables.

We have condensed our motion pattern data for Die Setting on an 8-1/2" by 11" card. An explanation of the content of the card is shown by slides that are Exhibit Number 2 and 3.* Examples of Basic Motion Patterns used in developing the data are shown in Exhibit Number 4.

Exhibit Number 5 shows a sample die standard set on a Number 1-1/2 L & J Punch Press. The method employed is not necessarily the best method to set a die. I only show this example to show how the basic motion data coding and time in TMU's are arrived at from our data.

Addition of the Allowances and How the Die Setters are Doing Under the MTM Standard Data

We do not allow payment of day work for any reason to a Die Setter. All necessary work that the Die Setter do is on standard. We took all day studies on all the Die Setters in a department simultaneously to determine allowances for personal, rest, and delays. We used these same studies to determine the allowance time for servicing presses. When a Die Setter services a press, the situation is one where he has completed setting the die, but he is called back by the press operator because of a problem that she is having. For example:

1. The parts are not blowing off the die properly and there is need for adjustment of the air lines.

2. A stamp in a die which is not making the proper stamp impression on the part and requires shimming.

3. There is a variation in material causing need of additional adjustment to the punch press.

We calculated a factor for servicing punch presses within a department by establishing the ratio of direct labor earned hours of that department to the total Die Setters' hours spent in servicing punch presses. We establish this factor from our all day studies. This factor is then applied to the Die Setters' time by the following formula.

$$\text{Service Percentage} = \frac{\text{Total Daily Direct Labor Earned Hours Times the Factor}}{\text{Total Die Setting Hours}}$$

This Service Percentage is then multiplied by each Die Setters' actual hours on Die Setting to determine his earned hour allowance for servicing punch presses.

Before the installation of Die Setting standards in a department, a meeting is first held with the general foreman and department foreman and the content and method included in standard are explained thoroughly. We also have a second meeting with the foreman and the Die Setters in the presence of their union representative. At this time, the Die Setters are given

*Exhibits number 2 and 3 are not included in the proceedings for the author feels that without specific guided instruction, the use of this card will only lead to misapplication of the data.

written instructions as to what is included in their standard and what their specific duties are. Forms are provided for reporting of production by the Die Setters. This form is designed to enable the foreman to check the die sets made by a Die Setter.

Before leaving the plant today, I picked up one of the latest Die Setting Reports from two departments on MTM standards and found the following percentages earned: In the first department one man earned 121%, one earned 85.4%, one man 140%, one 120%, and another 108%. In another department, one man earned 138%, one 108%, and one 125%. I would like to point out that the man that earned 138% declared firmly that nine die sets a day were the absolute maximum that a man could set on a Double Crank Punch Press in an eight hour day. Normally he was setting an average of seven to eight dies a day. In earning this 138%, he set and pulled 15 dies that day.

APPLICATION IV

EXHIBIT NUMBER I

ADJUST KNOCKOUT BOLTS (OLD METHOD)

Nut & Lock Nut Adjustment

	Occ.	Basic Motion Data	TMU'S
Get & Aside Tool	1	5A	133.1
Tool to 1st Lock Nut		5B4	22.7
Loosen & Tighten Nut	4	5H	107.2
Turn Nut w/Tool	4	5EC19	654.0
To Nut to Adjust	2	6D4	16.8
To Knockout Bolt to Adjust	2	6D4	16.8
Adjust Nut	2	6F20	632.0
Adjust Knockout Bolt	2	6F15	472.0
To Knockout Nut	2	6D4	16.8
Readjust Nut	2	6F5	152.0
			2223.4 x .0006 = 1.334 min.

ADJUST KNOCKOUT BOLTS (PRESENT METHOD)

Split Nut Adjustment

	Occ.	Basic Motion Data	TMU'S
Get & aside Tool		5A	133.1
Tool to 1st Nut		5B4	22.7
Loosen & Tighten Nuts	4	5H	107.2
Turn Nuts	4	5E1C9	654.0
To Knockout Bolt	2	6D4	16.8
Adjust Knockout Bolt	2	6F15	472.0
Tool to 2nd Nut		5B10	28.2
			1434.0 x .0006 ≡ .860 min.

Old Method 2223.4 TMU or 1.334 min.
New Method 1434.0 TMU or .860
.474 minutes per die set

35.5% saving on this element

APPLICATION IV

EXHIBIT NUMBER 4

BASIC MOTION PATTERNS USED IN DEVELOPING DATA

Basic Motion Number

1. Walk (wt. carried up to 35 lbs.) constant TMU 55.8 + W-PO (30" per pace)

   Motion pattern used to arrive at above constant TMU's

start walk	TBC1	18.6
finish walk	TBC2	37.2
		55.8 TMU's

   Example: Walk 20 ft. to inspector's bench
   20 ft. = 240 inches ÷ 30 inch pace = 8 paces
   W8PO = 136.0 TMU + 55.8 constant for start and finish walk = 191.8 TMU

5E - Turn nut or bolt using an open end or crescent wrench
Motion pattern used to arrive at turning either a nut or bolt one revolution with a 12" open and wrench in a confined area.

Confined area as defined in this data is any area where a nut or bolt is located in such a manner so as to restrict the axis of rotation of the wrench to less than 60 degrees.

M8B	6 occurrences	63.6
D1E	6 occurrences	24.0
M8C	5 occurrences	59.0
P1SSD	5 occurrences	73.5
Total TMU's for 1 complete revolution of a nut or bolt		220.1

5F - Turn nut or bolt using a box wrench
Motion pattern used to arrive at turning either a nut or bolt one revolution with a 12" box wrench in a non confined area.

Nonconfined area as defined in this data is any area where a nut or bolt is located in such a manner so as not to restrict the axis of rotation of the wrench.

M16B	3 occurrences	47.4
D1E	3 occurrences	12.0
M16C	2 occurrences	37.4
P1SSE	2 occurrences	18.2
Total TMU's for 1 complete revolution of a nut or bolt		115.0

APPLICATION IV

EXHIBIT NUMBER 5

SAMPLE DIE SET ON A #1-1/2 L & J PUNCH PRESS

ELEMENT	Occ.	Basic Motion Data	TMU'S	Total TMU's
1. Die Cart to Die Rack		2F200W19PO	86.6	
			323.0	409.6
2. Locate Die and Slide Die on Die Cart		7C	110.8	
		8	188.2	299.0
3. Move Cart With Die to Press		2F200W19PO	86.6	
			323.0	409.6
4. Die From Cart to Press		8	188.2	188.2
5. Lower Ram		9A	111.7	111.7
6. Position Ramhead Block, Position (2) Nuts and Tighten				
Get & position ramhead block		10	69.7	
Get, move, & position nut	(2)	6C8	66.0	
Run nut down w/fingers	(2)	6F11	344.0	
Get and aside tool		5A	133.1	
Wrench to 1st nut		5B4	22.7	
Run nut down w/wrench	(2)	5E1NC-18	337.4	
Tighten nut	(2)	5H	53.6	
Wrench to 2nd nut		5B6	25.0	1051.5
7. Loosen (2) Upper Ram Locknuts				
Get and aside tool		5A	133.1	
Wrench to 1st nut		5B6	25.0	
Loosen nut	(2)	5H	53.6	
Turn nut out w/wrench	(2)	5E1NC-18	337.4	
Wrench to 2nd nut		5B8	26.5	575.6
8. Adjust Ram (Turn Center Nut)				
Get and aside tool		5A	133.1	
Wrench to nut		5B6	25.0	
Turn screw w/srench		5E3C-12	660.3	
Bottom Screw		5H	26.8	
Ram down 1/4 (turn flywheel)		Analysis	77.3	
Wrench to nut		5B6	25.0	
Turn screw w/wrench (readjust)		5E1C-12	220.1	1167.6
9. Get Clamps, Bolts, & Block, Position Bolts & Tighten Lower Die Shoe to Bolsted				
Get clamp, bolt & block & position	(2)	6A	558.4	
Run bolt down w/fingers	(2)	6F2	56.0	
Get and aside tool		5A	133.1	
Wrench to 1st bolt		5B6	25.0	
Run bolt down w/wrench	(2)	5E6C-12	2641.2	
Tighten bolt	(2)	5H	53.6	
Wrench to 2nd bolt		5B16	133.6	3600.9

APPLICATION IV

EXHIBIT NUMBER 5

SAMPLE DIE SET ON A #1-1/2 L & J PUNCH PRESS

ELEMENT	Occ.	Basic Motion Data	TMU'S	Total TMU'S
10. Adjust and Tighten Knockout Bolts				
Get and aside tool		5A	133.1	
Wrench to 1st bolt		5B4	22.7	
Loosen & Tighten bolts	(4)	5H	107.2	
Run bolts out w/wrench	(4)	5E1C9	654.0	
Reach to knockout bolts	(2)	6D4	16.8	
Turn knockout bolts w/fingers to adjust	(2)	6F15	472.0	
Wrench to 2nd bolt		5B10	28.2	1434.0
11. Tighten (2) Upper Ram Locknuts				
Get and aside tool		5A	133.1	
Wrench to 1st nut		5B6	25.0	
Run nut down w/wrench	(2)	5E1NC-18	337.4	
Tighten nuts	(2)	5H	53.6	
Wrench to 2nd nut		5B8	26.5	575.6
12. Raise Ram		9A	111.7	111.7
13. Brush Grease on Leader Pins		18	436.1	436.1
14. Replace Barrier Guard		13	1237.9	1237.9
15. Replace Copper Airtube Turn on and Adjust Air		14	718.7	718.7
16. Position Belt on Flywheel				
Belt to flywheel		11	313.7	
To get pole and return	(4)	1W15PO	1020.0	
Walk constant	(4)	1	223.2	1556.9
17. Get and Fill Lubricant Supply				
Get and and fill lubricant		17	452.0	
Walk constant	(2)	1	111.6	
To and from lubricant supply	(2)	1 W10PO	340.0	903.6
18. Locate material For Blanking Samples and Return to Press				
Locate material and pickup pieces		20	106.0	
Walk constant	(2)	1	111.6	
To and from material	(2)	W25PO	850.0	1067.6
19. Blank Samples and Check Sample				
Separate analysis			1158.2	1158.2
20. Reblank Sample and Check Sample				
Separate analysis			1158.2	1158.2
21. Adjust Counter to Zero			154.6	154.6

APPLICATION VI

EXHIBIT NUMBER 5

SAMPLE DIE SET ON A 1-1/2 L & J PUNCH PRESS

ELEMENT	Occ.	Basic Motion Data	TMU'S	Total TMU'S
22. To Inspection Bench w/samples & Return				
Get samples & card for inspector		15	123.5	
Walk constant	(2)	1	111.6	
To inspector and return	(2)	W27PO	918.0	1153.1
23. Record Production				
Record production		16	564.7	564.7
				20,044.6

APPLICATION V

EFFECT OF MTM ON PLANT MANAGEMENT

by

John D. Bechtel

U.S. Naval Ordnance Plant

Before showing the slides depicting some of the effects MTM has had on management of the Naval Ordnance Plant, Forest Park, perhaps it would be well to give you some of the background of Government manufacturing operations. Most speakers at this type of seminar point out the age-old task of "selling" change, use of techniques and methods improvements, both to management and the worker. Industry has had the advantage of the application of industrial practices, even to the point of experimentation with improvements on the original philosophies of Taylor, Gilbreth, Gantt, usually with consent and backing of your top management officials. In 1910 the Watertown Arsenal attempted to install Taylor's system of scientific management. Worker pressures against change attracted a Congressional investigation, which resulted in the inclusion of a clause in the 1913 Appropriations Act which prohibited "the use of production studies" and which specifically prohibited the use of the stop-watch or any other means for measuring the amount of production expected of employees. This restriction was removed from the Appropriations Act for the first time in 1950. If you can imagine the amount of selling this task, try to imagine the task of convincing tradition hardened individuals to completely change their methods of approach to planning, scheduling, motion economy, and work measurement.

In 1949, our management bureau (now the Bureau of Naval Weapons) approved teaching the principles of motion economy to NOPF supervisors, provided no actual studies were made to establish time standards. In 1950, the Congressional restrictions were removed, and NOPF began studies which finally resulted in the establishment of an Engineered Standards Program in 1956. During this period, several areas were reorganized, the principle one being Production Planning and Control. Procedures for Production Planning and Control and feedback reporting procedures were established.

Our contract with the Methods Engineering Council required training selected personnel in:

1. Methods improvement techniques.
2. Principles of MTM.
3. Guided application.
4. MTM appreciation courses for executive personnel and shop supervision.

The objectives of the Standards Program were to provide a means for:

1. Close management control of costs and performance effectiveness.
2. Reducing costs and increasing productivity.
3. Improved planning, scheduling, and utilization of equipment.
4. A well-trained, functioning standards organization.

The MTM Program also assisted in:

1. Training supervisors to become more conscious of methods improvement opportunities.
2. Training operators in more efficient work habits and work place layouts.
3. Preparation of cost estimates for budgeting and quotation purposes.
4. Developing more effective tooling.
5. Expanding and standardizing the use of carbide and other modern cutting tools.

In spite of the painstaking preparations made to permit a gradual change from estimated

standards to MTM standards, many problems either existed that we were not aware of or developed during the period of installation. Since we operate a process shop, manufacturing operation sheets (route sheets) are prepared and set-up and operation times applied prior to issuing the job to production, which is usually several weeks later. Therefore, we applied time to specific jobs for testing purposes. These tests indicated four major problem areas:

1. Condition of and location of machine accessories.
2. Work place layout.
3. Inspection procedures.
4. Machine arrangement.

Management was already committed to "make MTM work." Anything standing in the path of progress became a challenge, not just to find a solution, but to solve the problem from a factual, analytical approach, which opened other avenues for improvement. Machine accessory inspection teams were assigned to shop areas for a fast determination of which tools were usable as is, those needing repairs, those not usable, and the proper quantity required. Accessories were relocated to reduce travel and search time. The arrangement of materials in relation to machines and the type of containers for castings, forgings, and parts at each sequence was changed to conform to MTM time allowances. Machine process inspection procedures were evaluated and changes made to maintain quality levels and reduce delays. Supervision and methods planners showed increased enthusiasm for reducing production costs. Analysis of production routing and the necessity for recording each step of every sequence provided more and more opportunities for improvements, improvements with little or no installation costs. Most of our management people accepted and became enthusiastic backers of the MTM program. Fringe benefits were reflected in better stores-keeping, prompt purchasing, better maintenance, and improved inspection. MTM training of practitioners and MTM appreciation courses for management set the stage for an all-out drive to create an attitude of cost consciousness. Sure we have our quota of disbelievers, those who now have a new angle for complaints and excuses. Some passive resistance is usually present in most companies who have dynamic progressive programs. Resistance to change is ever present. It would be too easy to expect complete agreement all the time. As long as we can get passive acquiescence rather than passive resistance from the few who haven't been sold on MTM and we can attain our goal for coverage and performance, we don't worry too much. But when these same people have hindered the program either by deed or lack of support, direct decisive action has been taken. Approximately 86% of direct labor is covered by engineered standards (MTM, time study, standard data), with a measured day performance of 83%, and we expect to reach 90% before the end of this year. This is with standards capable of application to an incentive program. This could possibly be a major program in the coming years. We have 44% coverage of the maintenance trades areas, which includes janitorial work, washing reflectors, and re-lamping operations, grass cutting and grounds keeping, etc.

A major program during the past three years has been the rearrangement of our entire plant. This required the relocation of all benches, machines, tool cribs, parts cribs, and test equipment in the production areas: consolidation of all manufacturing shops, storage areas, maintenance shops, and packaging and shipping facilities into the main building; the construction of a temperature-controlled electronic assembly room and a temperature, humidity, noise, vibration, electrical interference-free facility.

The relocation of shops and service groups was based on the flow of material through machining, heat treating, plating, and painting sequences, assembly sequences, and receiving, shipping, and inspection functions. Our products have changed from predominately machined and mechanically assembled to less machining and more electronic assembly operations. Our problems were many:

1. Many machines were originally mounted on wet concrete which filled the base cavities.
2. Over the years, machines had been relocated due to the transfer of vibration from machine to machine where extremely close tolerances were required.
3. Oil leakage through floor where basement areas existed.
4. Air and electrical lines buried in the wood block flooring.

Vibration studies were made of both machines and floor areas, which resulted in the decision to mount most machines and equipment on shock absorbent pads as Corfund, Air Lock, Isomode, and Unisorb. Electrical lines were

dropped to machines and equipment from main overhead power lines. Existing air lines were interconnected to reduce installation costs. Oil leakage through the floor over basement areas was eliminated by the use of air mist coolants rather than the usual flooding of the cutting tools with cutting oils and water soluble coolants. Air mist coolants are used exclusively on mills and engine lathes, and studies are underway to apply this system throughout the machine shops. By using this type of coolant, the machine is dry and easily kept clean, chips are dry and easily brushed off of parts and machines, degreasing costs reduced, coolant costs reduced, the costs of maintaining coolant levels and pumps reduced, and reduction in the cost of handling, storing, and shipping scrap.

From your attention, interest, and questions, it has been a real privilege to have this opportunity to present the MTM program at the Naval Ordnance Plant, Forest Park, and the total Bureau of Naval Weapons MTM program. We in Government Industrial Plants have a better opportunity to follow the successful practices of private industry—by attendance at seminars such as this one, industrial and management society conventions, articles in such magazines as Factory, Production, and Iron Age and, of course, through management and production handbooks and text books. Some of you are quite surprised (and perhaps pleased) to find that at least some Government plants are operating economically and justify costs in the same manner as you are.

APPLICATION VI

METHODS IMPROVEMENT

by

Edward Jones Jr.

Jones Dairy Farm

I am a member of the Jones Dairy Farm as Mr. Hansen has already indicated. We kill and process hogs in much the same way as any other packer with the exception that fresh pork link sausage amounts to approximately 35% of our total business. Our total daily production, which is highest during the colder months of the year, is about 30,000 pounds per day. It is the weighing and packaging of link sausage that I will talk about this afternoon.

In the fall of 1959 we changed our carton size from a five panel parchment lined butter carton to a longer, flatter carton. We made the change for various merchandising reasons, primarily for greater visibility and display value in the meat case.

Shortly after the new carton was introduced to the market, we experienced a substantial increase in sales. We felt that the increase was primarily due to the new carton. However, during the same period there was a general industry-wide increase in sausage sales which probably accounted for part of our gain.

Basically, our problem is this: When we started packaging link sausage in the new carton we suffered a severe loss of efficiency. For many years our standard hourly average had been 100 pounds per person per hour. Experienced operators were now only averaging 60 to 65 pounds per hour. Thus, it was necessary for us to hire additional help in order to bring our daily production back to normal, which at that time was 18 to 20,000 pounds per day. It was still apparent, however, that we had to increase our efficiency in order to meet the increased demand for our product and lower our packaging costs. During this period we tried to improve the scaling methods by trial and error and our scaling average increased slightly to 70 pounds per hour. However, most of the increase was probably due to the scalers becoming familiar with the new carton.

When we realized that our efficiency had leveled off, we decided to employ some outside advice for improving our operation methods. From past experience with A. T. Kearney & Company, we decided to employ their services. Shortly thereafter their representative started working at our plant.

After an initial study, we proved that all sausage making operations, with the exception of sausage scaling had sufficient capacity to supply our needs for the increased demand. Therefore, effort was concentrated on improving the sausage scaling and packaging methods. Due to the fact that we had never made any attempt to standardize methods, averages of individual operators ranged from 45 to 100 pounds per hour. Each operator used her own method. Some methods were fairly good and others were poor. Even the best operators used some inefficient motions.

The work place layout for this operation remained the same in the change from the old to the new carton. (See Exhibit 1.) It consists of a stainless steel chain conveyor with scaling tables attached to opposing sides down its length. Each weighing table measures 24" x 42". The 42" side of the table is situated at right angles to the conveyor. The operator sits in front of this side facing in the opposite direction of the conveyor motion.

The equipment on each table consists of an Exact Weight Shadowgraph Scale, a raised platform for flat unused cartons, a small pan and a small hand knife.

The supply of unpackaged sausage is located at the end of the table farthest from the conveyor. The small pan for excess sausage meat is situated between the stockpile of sausage and the scale. The scale is in approximately the center of the table. The supply of cartons is located between the scale and the conveyor and the

small hand knife is at the right or the left-hand side of the scale depending on whether or not the operator is right or left handed. Sausage is continually supplied to the scaling tables.

In brief, the old method used for scaling sausage with the five panel butter carton is as follows:

1. The carton was placed on the scale.

2. An approximate pound of sausage was piled on the carton on the scale.

3. The operator cut the approximate pound of sausage from the remaining strand of links.

4. The operator adjusted the approximate pound by adding or cutting off links and for small overweights by removing some of the sausage meat in order to arrive at the correct weight.

5. The weighed pound of sausage was arranged into a block the size of the carton and then placed back on the carton.

6. The carton closed and formed by rolling the sausage up in the carton and then forming it into a square and then closing each end.

7. The finished package was placed on the conveyor.

The MTM analysis of scaling and packaging was started after the new carton was in use. Many inefficient motions were discovered. The first to be corrected was precreasing the flat cartons in groups of 100 or more. This motion pattern had evolved because of the greater difficulty in closing the new carton. However, it was completely wasted motion because the operation was repeated during the scaling operation. Although the precreasing operation only cost us one pound per hour for each operator, over a year's time, it would amount to an 83,000 pound loss.

The first motion pattern in the job for the final analysis is to place the carton on the scale. This operation involves reaching for the stock of flat cartons, grasping the top one and placing it on the scale. At this time the two end flaps and the front flap of the carton are creased. Also, the carton is prepositioned in the stockpile so that the locking tabs are away from the scaler when it is placed on the scale. The reason for this comes into effect when the box is closed.

The second motion pattern is to scale and pack the sausage. A small knife is held in the palm of the hand.

It is very important to note that the knife is held in the hand during this and the following motion pattern. When the analysis was started it was found that a good deal of time was lost in repeatedly picking up and laying aside the knife. By having the operator palm the knife throughout the operation of scaling, packing and making weight, about 8 pounds per hour were gained. This gain over a year's time would amount to almost 500,000 pounds.

The next part of this pattern consists of forming two approximate half pound units of sausage.

Our sausage is generally sold frozen. Consumer complaints and our own experience indicated the difficulty in separating a portion of the sausage links from a frozen one pound block. Therefore, we found it desirable from a merchandising standpoint to have a carton consisting of two approximate 1/2-pound units. Also, because the carton is flatter and when opened exposes the full links instead of just the link ends, more care is required in the forming of the half-pound units. This decision cost us our greatest lost in efficiency.

The first one-half pound unit is formed in one hand by folding and looping the sausage with the other and then cutting off the approximate half-pound from the remaining strand of sausage. This half-pound is then placed in position on the carton on the side nearest the conveyor. This is done in order to minimize the reach and move in forming the second approximate half-pound, which is the next operation.

Our sausage is stuffed into natural New Zealand Lamb Casings. Each linked strand is about 40 feet in length and weighs between 6 and 7 pounds. Therefore, it is necessary to cut the half-pound units away from the remaining strand.

The third operation is to make the correct weight which involves adding or cutting off links for large overweights and removing some of the sausage meat from a link for small overweights. When sausage is removed from a link, it is placed in a small pan to the right or left of the scale. Our weight tolerances are from net weight to 1/8 of an ounce overweight. The scale is checked once again for correct weight after the pound of sausage has been adjusted.

Then the knife is placed aside. Thus, the knife has been held in the hand throughout the scaling, packing, and making correct weight operations. It is picked up and layed aside only once throughout the whole operation.

The fourth operation is to form and close the box. This operation also cost us some loss in efficiency as it is a more complex carton to close. The operation involves folding up the end flaps and the front flap. The carton is held with both hands holding the end flaps in position and pushed back against the stop on the rear of the scale platform. In effect, this creases the back side of the carton and brings the cover into easy closing position. The cover is then pressed down and the locking tabs are inserted in the front side of the box.

The reason for orienting the box on the scale with the locking tabs to the rear is necessary so that when the operator snaps the locking tabs into position they are on the side of the carton facing her. We found it very difficult to close the carton when the locking tabs are on the side of the carton away from the operator. After the carton is closed, it is then placed on the conveyor.

Each operator has to supply her own flat cartons from a box on the floor. This requires another motion pattern. The operation involves turning toward the box on the floor, bending over, reaching into the carton, and grasping approximately 100 cartons. They are then placed on the platform next to the scale. During the MTM analysis we found operators to be picking up 300 or 400 cartons at once. Through analysis we proved that it was better to pick up 100 cartons. (In other words, a two-inch stack rather than a 6 or 8-inch stack. Although the operation had to be repeated more often, it was more easily done. It could be done with one hand instead of two, and it eliminated any fumbling and many finger motions from the method.) In addition to that, a stack of 400 cartons would be six inches higher than the stack of 100. Therefore, each time the operator reached for a carton, she would be reaching six inches farther than necessary for each pound. As the stack decreased in height, her reach and move would also decrease. However, with a stack of more than 100 she was always reaching farther than necessary. With 100 carton stack the excess reach is only one inch for about half the time.

At the completion of the analysis, the method was presented to the employees by the management. We called in small groups of scalers and handed out printed sheets such as I have here describing the method just as I have given it to you, only in less detail. At this time we discussed with them each part of the total scaling cycle and answered any questions that arose. We also discussed and worked with them on the type of knife which should be used. We purchased several samples of small hand knives and had our women find the one which they liked the best. The knife decided upon was one with a 2-1/2" blade and a 4" handle which is oval in cross section. The handle is also slightly tapered from front to back so that it fits comfortably in the palm of the hand. Also, when the knife is grasped, the cutting edge is easily oriented with the fingers due to the oval shape of the handle. We standardized the type of knife because previously they were of many shapes and sizes. All of the old knives had at least 4" blades and handles too bulky to hold in the hand while performing other operations.

We were confronted with some difficulty in getting the operators to believe that they could palm the knife successfully. We felt that a short bladed knife would be better since there was a good deal of apprehension from the operators that they would cut themselves continuously. However, after a week or two of using the method of palming the knife, all of them were well satisfied that it was much easier.

Another point I want to add is this: The older operators, many of whom have been with us for 15 or 20 years, had more difficulty in learning the new method than did the new operators. However, I believe that this is a perfectly normal reaction.

(Exhibit 2)

Please refer to Exhibit 2 at this time. As you can see in your graph, the method standardization had a great effect on raising the total averages in a relatively short time, almost 40%. Obviously, we are very well satisifed with the results made by method improvements and we plan to carry this on further throughout our plant.

In the future we plan on analyzing all of the jobs in the sausage making department. These consist of grinding and mixing, stuffing the sausage into casings, and hanging the link sausage onto sticks to be precooled before weighing and packaging. Incidentally, the condition of the sausage is quite important in the sausage weighing operation. The precooling stiffens and dries the product and makes it much easier to handle.

We have also done some MTM work on our kill floor, especially on the head bench. The operations there consist of trimming inedible glands from the head, removing the tongue and trimming off edible red meat. In addition to the head bench, all of the jobs on the kill floor could be analyzed in order to balance out the work load throughout the whole line.

We have also found random work samples useful in finding various parts of the plant where MTM can be applied with good results in the future.

In conclusion, I would like to note that the MTM analysis of the sausage scaling operation was made as a basic study. It was not made to base incentives on. In order to use this analysis for incentives, we would have to refine many of the details.

APPLICATION IV

EXHIBIT I WORK PLACE LAYOUT

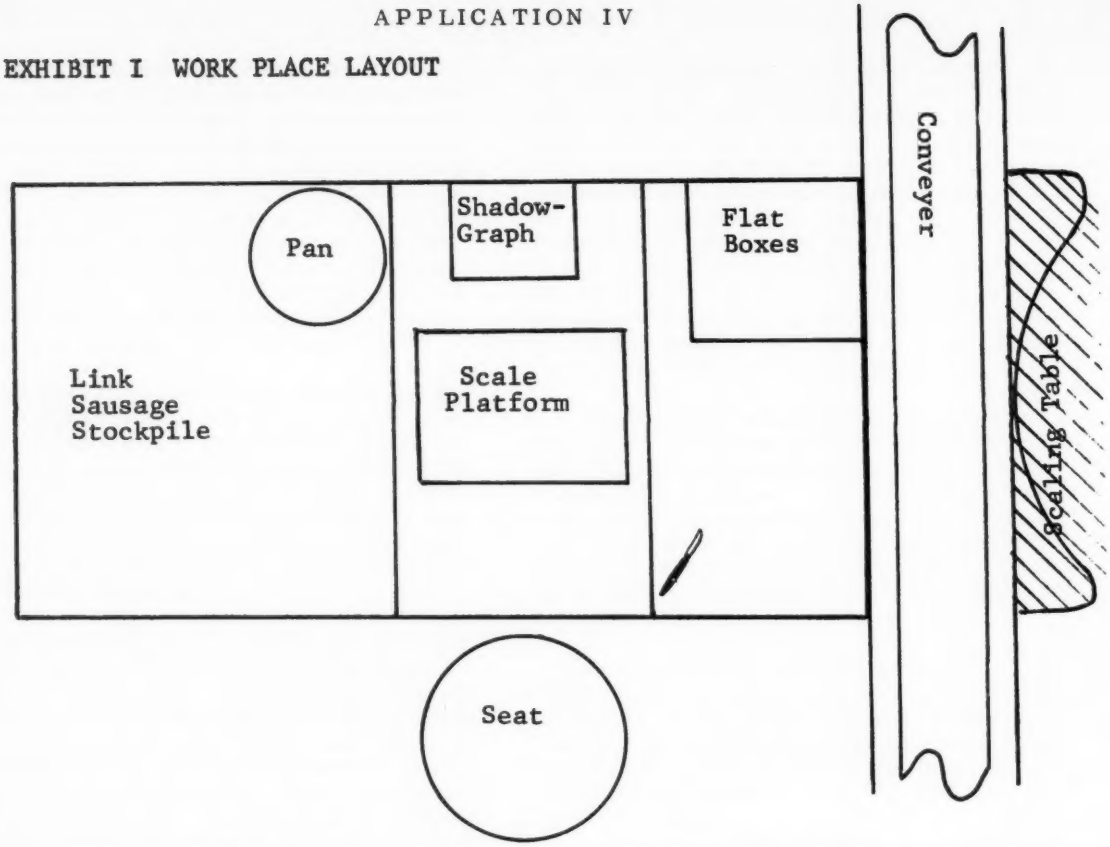
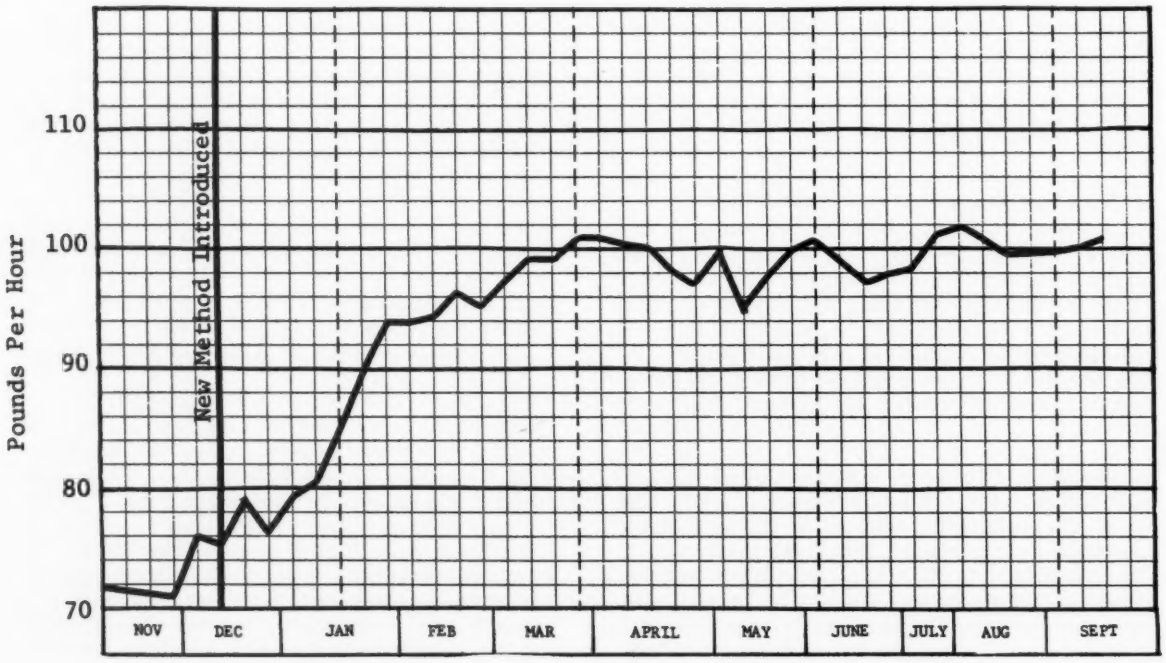


EXHIBIT 2 - WEEKLY TOTAL OPERATOR AVERAGES NOV. 1959 - SEPT. 1960



INTERNATIONAL

Standards for Office Work

by

H. P. Bakkenes (Netherlands)

Why Standards for Office Work?

The cost problem in an enterprise can be considered the central problem. The importance of this problem will be first noticed in the industrial production. For this reason it is understandable that industry was the first to start to control the costs of production.

For a long time this was restricted to the costs of direct man and machine work as well as the consumption of material. This is easily explained because these costs form the most important part of the production costs.

However, in order to control the cost price it is necessary to provide standards which make it possible to check the real costs. These standards can be reached in various ways. Besides statistical methods, the most useful method to establish standards is time measurement. It is explainable that, because of the importance of the direct manufacturing costs, (especially at the place of production) the use of work measurement has become a normal practice.

However, during the last years we have noticed a tendency—especially in the wage costs—that the indirect labor costs increase considerably in relation to the direct labor costs.

Therefore it becomes more and more necessary to control also the indirect labor costs. For these, too, standards—that is objective measurements—are absolutely necessary. Since the indirect labor costs consist mostly of wages for administrative work it is very important to establish standards for office work.

Selection of Measurement Technique

Generally, the same organization technique which is used in the production section can be used for efficiency improvement of office work. The same principles apply to both fields.

Therefore, if measurements are considered the stop watch can be used without question. It shows, however, that office personnel complain about the use of stop watches. The reason for this is usually of psychological nature and well known. Statistical methods are therefore often preferred for the organization of administrative work.

MTM people know that there can be little psychological objection against this procedure. With administrative work it is well possible to simulate the work situations and develop time standards in laboratory experiments. Especially for administrative work the use of MTM instead of the stop watch should be preferred and that not only for psychological reasons.

It Is Necessary to Provide Basic Elements.

Every MTM expert is basically capable to establish a standard time for each manual work by recording a sequence of motions. This is also true for administrative work. However, there are many administrative operations whereby for each operation a great number of variations is possible.

For example, if we look at the operation "Invoice" we find, among others, the following variations:

1. of method:
   1. handwritten
   2. use of typewriter
   3. punch cards, etc.

2. of forms:
   1. single copy
   2. more than one copy
   3. chain forms
   4. sets glued on top
   5. sets glued on bottom
   6. loose sets
   7. single carbon paper
   8. more than one carbon paper

3. of contents:
   1. number of items varies
   2. number of amounts varies
   3. number of figures per amount varies.

Above mentioned variations are only a few examples.

It might be enough to establish the sequence of motions for the used type of invoice, however, with regard to the control of the cost level it is particularly important to know whether another method might be more profitable. This would make it necessary to record more than one sequence of motions.

It is clear that analyses of all these variations are not only costly but, first of all, a time consuming matter; but occasionally standards must be available in a very short time, i.e., for the decision to purchase new machines.

Thus, the use of MTM for office work implies the establishment of basic elements.

What Is Known at Present About Basic Elements of Office Work?

A characteristic of basic elements is that they can be applied in all comparable situations. This includes that they do not only apply for a certain company but also for each company within the same branch of industry. (For some industry branches basic elements are already known, i.e., clothing industry.)

Only little has been published in Holland about basic elements for administrative work. Mr. S. A. Birn has stated in a lecture for the "Werkgroep Administratieve Arbeid van het N.I.V.E." (January 1959 Hilversum) that he can provide a great number of basic elements for office work. The examples which he published show that his basic elements generally consist of the construction of three to four basic motions. As a result the elements are small, their number however is large which is of no benefit for a convenient application.

Of quite different nature are the basic elements which were established by the "Study Center for Office Work" of the Unilever Concern in Rotterdam. This center has been occupied for 5 years with the establishment of basic elements for office work and the success is so interesting that it is worthwhile to investigate it further.

Results of the "Study Center for Office Work."

In outlining the basic elements, the Study Center for Office Work proceeded with the idea that the following demands must suffice:

1. General possibility of application
2. Include general occurring routine tasks
3. Be handled simply and quickly

This intention was quite successful.

Standards for the following categories have been outlined:

Arithmetic
Count
Transcribe
Type
Collect
Mail
Assort
Take out punch cards

It appears that the main portion of office work is included in these categories. The basic elements are shown per task in clearly arranged tables of about 300 pages. This small volume secures a convenient handling.

Before this result was reached a thorough investigation of the task concerned was necessary. This examination did not only include the work method and sequence of motion to be followed but also statistical examinations of the frequency which has to be taken into account. (Theory of probabilities to hit the right card or form in an arranged or unarranged file.)

The investigation also included the comparison of different work methods which made it possible to indicate at what amount of work a certain method is most useful. As an example, the construction of the basic elements for transcribing will be explained in more detail.

Basic Elements for Transcribing

In order to reach an appropriate outline of the basic elements for the time necessary for transcribing, the transcribing was divided into four kinds of part operations:

A. Pick up and file away the document (I) from which the dates shall be read.
B. Pick out and file away (in right order) the document (II) on which the dates shall be written.
C. Read on document I the dates to be written.
D. Write these dates on document II.

For each of these part operations the number of variations is limited. By establishing the

normal work time for each part operation the time for the complex total operation can be established. In setting up a table for basic elements it has been proceeded from a number of conditions:

1. Additional unusual operations were not taken into account; they must be added to the found standard time by means of a percentage.

2. The mentioned work times apply to normally skilled persons.

3. It is assumed that the dates to be transcribed are well legible.

4. The times for writing are figured for a clear handwriting.

5. It is assumed that blotting is not necessary.

The table for manual transcribing consists of 2 pages and includes 4 sub-tables—one for each of the above mentioned part operations.

Table: Select and File Away of Document I

The sub-table for pick up and file away the document from which is to be read is very simple and consists only of the standard time per 100 documents = 2.8 min. In analyzing this standard time it was found that there are only two possibilities for variation in this method:

1. Take the document from reading place to filing place without turning it.

2. The same with turning it.

Both motion sequences had the same time formula as a result: 30 + 0.3 x whereby x = distance which the hand passes in turning the document. In the tables a distance of 55 cm (=21 inches) has been figured (for size A4 and A5). The simplified MTM time value card was used in the analysis.

Table: The Reading of Dates on Document I

In establishing the times for this table the following variations were taken into account.

1. The number of figures of which the dates to be read consist.

2. Where the dates to be read on document I are placed.

   a. on a fixed place
   b. on a scale
   c. on a scale with an indicated space mark of more than 10 cm (3-3/4")
   d. in a table with two entries

3. The number of lines of the scale

   a. up to 20 lines
   b. up to 40 lines
   c. up to 60 lines

4. The number of columns of the scale

   a. up to 20 columns
   b. up to 40 columns
   c. up to 60 columns

The peculiarity of this table is that EF ad 7.3 TMU which is normally used in MTM has not been used, because, the research that had been done proved that for the reading of the words and figures in the operation the EF value is not sufficient. On hand of the available literature a new EF value was found which consists of three parts:

Focus	F	4.5	TMU	per	3 figures
Perceive	P	4.5	TMU	per	3 figures
Remember	M	2.1	TMU	per	figure

The starting point is here that no more than 3 figures are perceived and remembered at a one-time reading.

Table: Write the Dates on Document II

Different tables have been published for the writing of figures and the writing of words. The following was used as influence sizes:

1. The number of digits per figure
   The number of letters per word.

2. The place where to write:

   a. fixed place
   b. on a scale
   c. on a scale with space mark of 10 cm (= 3-3/4")

Table: Select and File Document II on Which Dates are Transcribed

For this operation, too, the table has been divided into two parts:

1. Times for pre-assorted documents II
2. Times for not pre-assorted documents II

The worked out variations are:

1. The used card-index system:

1. Loose piled up leaves
2. Book a) 200 pages/book
   b) 500 pages/book
3. Agrippa
4. etc.

2. The work rates.

Especially for this table it was necessary to establish an extensive number of motion sequences. For this a number of possibility calculations was necessary in order to establish the normal frequencies of some of the "seek-out operations."

The Application of the Transcript Table

1. Task: 500 invoice copies of 100 different debtors are to be transcribed into a non-visible 5000 card-index system.
   The invoices are pres-assorted according to debtor numbers.
   Transcribe per invoice:

Date	5 figures
Number	5 figures
Description	10 letters
Amount 40%	6 letters
Amount 60%	3 letters

2. Time Value

Table A: 100 invoices take up and file away — 2.8 min

Table B: 100 debtor cards pick out and file away rates = 100/5000 = 1/50 — 16.8 min

Table C: Read dates of 100 invoices

On a fixed place

Date	5 figures	3.6 min
Number	5 figures	3.6 min
Description	10 letters	1.8 min
Amount	40%: 6 figures 0.4 x 3.6 =	1.4 min
	60%: 3 " 0.6 x 1.8 =	1.1 min
		11.5 min

Table D: Write dates on 100 cards

On a fixed place

Date	5 figures	11.8 min
Number	5 "	11.8 min
Description	10 letters	14.7 min
Amount	40%: 6 figures 0.4x13.4=	5.4 min
	60%: 3 " 0.6 x 7 =	4.2 min
		47.9 min

Total: 79 min

Check

In order to examine a practical application possibility for standard times for office work according to the Center of Study for Office Work, a number of spot checks have been made. The following is the result of one:

The task was analyzed: "Calculate the wages of a shift paid piece rate." This task consisted of 62 operations. For the analysis of these operations only 4 standard time tables were necessary:

1. Count (machine and non-machine)
2. Arithmetic (machine)
3. Transcribe (on loose leaves)
4. Assort (manual)

On hand of these tables a standard time of 73.109 TMU was figured for this task. Later on time studies of this task were made using a stop watch. The standard time found thereby was 75.281 TMU which means a difference of 2.9%.

Conclusion

It is practically not possible to show in short form the entire structure of the above described standard time tables. We must be satisfied here to mention the existence.

However, the description will be sufficent to indicate that:

1. it is possible to establish useful standards for office work,
2. MTM is an extremely helpful means for the establishment of these standards,
3. the basic elements prove their usefulness only if they exist in a form that makes a convenient application possible.

April 25, 1960

INTERNATIONAL

INTEGRAL USE OF MTM

by

Ivan Edman (Sweden)

INTRODUCTION

Sweden has today the highest labor wages in Europe. If I were a labor representative I would probably make this statement with greater pleasure and confidence than I can as a representative of Swedish Management. Management people in Sweden are well aware of the extra burden which our high wage level represents, when we want to compete on the international market.

Recently we have been faced with an entirely new set of market conditions: the market integration among the seven and the six European countries. This will make it necessary for Swedish industry to insure that our efficiency and productivity are on the same higher level as our labor costs. Otherwise it will have an extremely serious influence on our whole standard of living.

In Swedish industry we have used work measurement to an ever increasing degree since the beginning of the 1930's. Unfortunately, until 1950, time study was the primary tool used and often used for the single purpose of establishing incentive payment. Work measurement directly concentrating on methods development and work simplification did not begin until 1950.

I do not think that I exaggerate when I say that the introduction and use of MTM in our industry has been of major significance. MTM has given a new dimension to our work measurement endeavors.

We have begun to understand motions and motion time. Method is no longer simply a definition of the sequence in which the work is to be performed. The concept of method has now been expanded to include all of the factors which can affect the time to do any given job. And in our Swedish industries manual motions still play a predominant role and will continue to do so for many years to come.

This development of our work measurement program has placed us in a much better position to understand and control our efficiency and productivity. If the tempo of this development can be increased to an even higher degree, then perhaps we can gain the necessary productivity level which will enable our people to retain their higher level of wage income and standard of living.

VOLVO-PENTAVERKEN

Our company, Volvo-Pentaverken, is one of the five companies which make up the Volvo Concern, our country's largest automobile manufacturer. The Pentaverken factory is responsible for the manufacture of the Volvo engines. We have, besides a number of machine shops and assembly departments, a very modern and important foundry. The total employment at Volvo-Pentaverken is approximately 2200 workers.

Volvo-Pentaverken, where I am a member of Management, is the enterprise which I will discuss in this presentation. We were the first company in Sweden to introduce MTM. Because we are in the automobile industry, we, like all other automobile manufacturers, keep in close contact with the United States. Therefore, we came in contact with MTM at a very early stage and began our first MTM installation as early as 1951.

This first MTM installation was made in our foundry. After that we introduced MTM into several of our machine shops.

Later came a number of installations in our indirect labor departments. I shall, as briefly as possible, review the more important developments and experiences from several of these applications.

MTM IN THE FOUNDRY

The MTM-installation in the foundry was

our first and perhaps our most interesting installation. We, at that time, had no previous experience with the MTM procedure and standard times. It was therefore natural that we were very inquisitive about application of this new procedure. We asked such questions as:

> "The MTM standard time values were developed for American conditions and through study of American workers. Are these time values applicable for our conditions and our workers?"

> "Are the MTM standard times sufficiently accurate to serve as a basis for incentive payment?"

> "How will our foundry workers react to all this new method of work measurement? They had previously rejected the use of time study?"

We were on the verge of starting production in a new foundry. We were for the most part going to introduce new machines and equipment which was to replace our old foundry.

> "Would MTM ease the problem of starting production with all this new and modern equipment? Or would the use of MTM bring about disputes over wage incentives and work methods?"

Yes, we had these questions in our mind and several more, to which we could give no answer at that time.

In spite of this, we decided not to limit the use of MTM to methods study and cost estimating. We reasoned that as long as we were going to try this new method we should apply it in its fullest meaning and even use the standard times as a basis for incentive payment.

We have never had any reason to regret this decision. As a matter of fact, it has proven to be a very wise decision which in many respects has produced very spectacular results beyond our expectation.

We succeeded in getting a very rapid start of production in the new foundry. We got a quick answer to our key question of whether or not MTM standard time could be used for our own Swedish conditions. We found that our workers had no major difficulties in meeting MTM's standard time level. On the contrary, our average foundry worker came up to a performance level which, on the average, was 20% above the MTM norm. In those occasional cases where workers had difficulties in meeting the standard times, it was found that in nine out of ten cases it was because the worker had not followed the specified work method. The incentive pay was obviously based upon this specified work method. In each case we gave the worker additional instruction in how to follow the proper method. This, as a general rule, gave the result that the worker quickly reached the normal incentive performance level. Therefore, we have to our satisfaction proven that practically every foundry worker employee, who is suited and capable of this work assignment, can meet the MTM standard. And he can as a rule go beyond it with a very good margin.

We also found something else which we felt was of major significance. We were able to start production in this new foundry with its several hundred workers on MTM incentives without having one single serious dispute about the incentive rates. Naturally there were discussions. But those concerning the manual portions of the work elements were easily disposed of. Because we had in our MTM analysis been provided with all the facts which were necessary in order to give a proper answer during such a discussion.

INFORMATION AN IMPORTANT PART

We started the MTM installation in our foundry without any contract agreement with the workers. However, from the very beginning of the program we gave them detailed MTM information. We also showed them how we intended to use the MTM procedure in preparing for the production work as well as for incentive calculation. Each worker, who was moved into the new foundry, started by receiving four hours of MTM information. The five representatives of the foundry union received the complete three weeks of basic MTM training. In addition to this we held meetings with the union representatives every two weeks during the entire installation period. During these meetings we informed them of the progress of the installation and gave them an opportunity to bring up various questions for discussion.

I have emphasized information and training of the workers because I feel that it was one of the most important measures we used to insure a successful acceptance of this new technique. Conventional work study had previously met with great resistance from the workers in this area. Proper information was of the utmost importance in this case. As a matter of fact I personally feel that training and information to the workers is equally important regardless of where this technique is to be installed.

THE CONTRACT QUESTION

By 1955 both we in Management and the workers felt that sufficient experience had been gained with MTM and that we had reached the point where we could write an acceptable agreement for its future use. That same year we were able to include a new section in the general collective agreement for the entire Swedish metal industry. This section made it possible for each company to negotiate locally with the workers about the use of MTM.

When we in Sweden today look back upon this event, we feel that the addition of this new section in the general agreement was a very important turning point for the technical production development in our country. It has meant, that our entire metal industry has received the support of the central union organization for the use of MTM in methods development and in the use of MTM for setting production standards. It provided us with a potential guarantee that people within our industry in Sweden can produce products with effective work methods. It meant that our industry can reach a fair degree of work hour utilization through the development of accurate production standards. In other words, thanks to the positive attitude of the workers and the unions to MTM, we have åll received an increased opportunity to keep pace with internation developments. We will better be able to keep our products competitive in spite of the high labor wages which our industry must absorb.

MTM IN OUR PC ENGINE PLANT

With the practical experience we gained from the MTM installation in our foundry we decided that it was highly desirable to extend the application of MTM to our machine shop. We got a very convenient opportunity during 1954 and 1955. Because of the increased production requirements for PC-engines, that is, passenger car engines, we were forced to move production into a new area. At the same time we had to procure additional new machines and equipment in order to give us the required increase in production capacity. In many respects, we had here an even better opportunity to realize the full potential value of MTM than we had had in the foundry. In the foundry the plant layout, machines and tools were for the most parts completed before we began with the MTM application. In the engine plant we had a much fuller opportunity to use the methods study principles of MTM all the way from the project planning stage through the process engineering stage, to and including the actual start of production. Instead of being limited to certain particular aspects of the manufacturing process, we had here the possibilities of achieving a maximum economic result by using methods and motion study to shape the entire production activities.

MANUFACTURING TIME REDUCED TO ONE THIRD

The results we achieved in the engine plant surpassed all our expectations. We reduced the man hours per engine to one third of what it had been in the past. It would be misleading, however, to think that this entire substantial saving came about only through the use of MTM studies. The new machines and equipment had a very important share in this result.

Rationalization through capital investment in new machines and equipment is frequently used and often gives a good return. When we planned the new engine plant we found, however that the return for the investment we made in MTM methods study was considerably better than the return from capital investment. We found that the man hours of labor we were able to save through methods and motion studies were many times larger than the man hours saved by new machines and equipment when we measured it against the dollars spent.

Because of this finding and because the limitations placed upon capital investments, we limited the procurement of new machines to those which were absolutely necessary for building up the required production capacity. We have later made a cost comparison of what it cost in investment to save the equivalent of one production worker. It shows that we in our plant through rationalization in connection with the production increase saved one production worker by spending:

(a) 7,000 Swedish kronor in methods study
(b) 50,000 Swedish kronor with investment in new machines and equipment

This investment figure was actually necessary in order to reach the required machine capacity. We selected these machines however, with great care, and they were decidedly more efficient than any previous machines we had used. The above figures demonstrate very clearly that we have made very substantial savings and been able to stretch our investment dollar considerably by allowing MTM methods studies to play the major role in our rationalization program. The figures in this comparison are naturally limited to this particular manufacturing department. We will certainly get a different set of figures for other departments or types of production. We can safely assume that they will vary because of the different conditions which prevail and of

the degree of rationalization which has already been achieved. We feel however that the use of methods studies, for our industries characteristics, will most probably continue for many years to be the most profitable means of rationalization. At the same time machine investments will be limited to only those investments which are necessary to compensate for obsolete equipment and which at the same time contain increased machine capacity when such is required.

During the development of the new engine department we actually completed the major portion of the rationalization work during the project engineering stage, that is before we actually started production. This is not only the most effective way to rationalize, but also the most economical. The whole basis for this approach is that we during the project planning stage, can measure and decide on the profitability of various alternative production methods. If we can not make such measurements, but must resort to guesses and rough estimates, then we have no guarantee that we have selected the most effective work methods and the most suitable machines and equipment. The technical personnel, who were in charge of the project planning and methods engineering work for the engine plant, had all received the full MTM training. They could, even during the preparatory work, make all the necessary work measurements with greater accuracy than would have been possible otherwise. This way the MTM approach gave us a higher guarantee that even the new machines, tools, and miscellaneous equipment were properly selected and would be efficiently used.

PREPARATION AND INSTALLATION

The methods personnel who is engaged in the development of the PC engine plant were divided into two groups. The first group which we called the methods planning department, was responsible for plant and machine layouts and, with assistance of the tool design department, responsible for design and procurement of machines, tools and miscellaneous equipment. They were also given responsibility for all estimating which included investments as well as production times and production costs.

The second methods group which was called the methods installation department, worked together with the production preparation group when buildings, machines and equipment were delivered. It was this department's responsibility to develop work places and work methods in detail, as well as distribute and balance the work load at the various work stations on the production lines. They were also given responsibility for the establishment of incentive rates and production standards.

We have found this form of organization to be very suitable in our industrial engineering work. It has therefore been maintained even after the primary assignment in the PC engine plant was completed. We have found that this division of responsibility gives a very good coordination in the job of preparing for production. It also gives the methods technicians a chance to become specialists in their own particular areas.

While the methods planning group digs into the next production projects or departments, then the installation group finishes off installation of the previous project. In this way the methods planning group will not be hindered in its work because of minor detail questions. We have been able to maintain better continuity and preparation for production and our over-all time schedules have been easier to maintain.

We have had no great problems in transferring basic information and data from one group to the other, because they generally work in close contact with each other, and also because we with our MTM approach, have been able to describe the processes and work methods in great detail.

We do not only achieve highly developed work methods with the MTM approach. I would like to especially point out the additional value of the methods descriptions for the instruction of personnel, for the rapid understanding of new work methods, and finally for the use in balancing production lines to the very best degree.

SHORTER TRAINING TIME

Work methods and incentive standards in the engine department were to a large extent developed before any worker was assigned to the various work places. This, combined with the detailed methods description which MTM gives us, made it possible for us to start producing in the new plant facilities and have every man producing at the required performance level in a shorter time than has ever before been possible. We had eliminated the time consuming hit and miss system, where the workers themselves will have to search for an appropriate method. The methods required to perform each operation, motion by motion, could be demonstrated from the very first of production.

The result of this was that no worker required more than a maximum of twelve days, and on the average not more than five days, to reach full production pace, which was established at the 110% MTM performance level, or in other words, a performance level which is 10% above the MTM standard.

MORE ACCURATE LINE BALANCING

The new layout of the PC engine plant is based primarily on line production. This means that each work piece passes from one station to the next without any inprocess storage. This way we saved transportations, material handling, containers, and storage space, and at the same time we reduce the over-all cycle time to a minimum. But line production not only brings you advantages, it also creates problems. A typical and difficult problem is the division of work on the line. Many difficulties arise in the dividing and balancing of work between the various work stations. The most efficient situation from a man hours viewpoint, is that the workers on the line are all assigned an equal work load.

The methods installation department solved the balancing problems in this new plant by using the predetermined time standards. This enabled them to make a detailed division and assignment of work to each work station before production began on all the various lines. They could also beforehand accurately determine how many men would be required on each line to maintain the desired production volume. Before any personnel was moved into a line, we provided them with clear instructions of what each man's assignment would be and of the method he should follow. We also told him how much to produce so that smooth production flow can be maintained throughout the entire line. The problem of calculating incentives on line production has previously been a rather difficult problem. Now it was properly solved with the help of MTM.

THE USE OF MTM IN INDIRECT DEPARTMENTS

I have up to this point limited my discussion to the use of MTM in our production departments. Before I finish, I would like to say a few words concerning the use of MTM in some of our indirect departments.

When we first came in contact with MTM we thought it was primarily suited for repetitive work with short cycle times and long series of the same product. Later we found out that MTM can be adapted just as easily to short series of products, and even to single piece production with long operation times. The difference between these areas of application is only in the manner in which you apply MTM. On highly repetitive work the methods and time analysis for each operation is made motion by motion. When we go to single piece production then the basic analysis is made only once and will include all the methods improvements and analysis for the class of work studied. These basic analysis are then used to build large methods elements, such as standard data and time formulas, which then can be used for the determination of time standards. Now because we have made the major portion of the methods improvements during the development of the standard data and time formulas, we can, once the data is complete, determine the individual and final time standards rather quickly.

THE USE OF MTM IN TOOL-ROOM WORK

We introduced MTM as early as 1953-54 in our tool making department. Today one rate applicator can with standard data and time formulas determine the time standards for 20-25 tool makers. Our rate applicators do not only calculate time standards. In addition to their standard setting work they also plan how the work is to be done and provide a special methods card containing all pertinent methods information. Because of this additional work we estimate that one rate applicator in our toolroom today will cover about 15 tool makers. But even so we have realized substantial net savings by using this form of MTM application. The rate applicator actually plans every job for these 15 men and will at the same time determine accurate incentive rates.

Our tool department is not sufficiently large to keep pace with all the jigs, fixtures, and miscellaneous tools which we require. So we purchase a portion of our tools from outside companies which are specialists in the manufacturing of tools. A few years ago we made a comparison with one of these companies. It revealed that our tool making labor time was 40-50% less than their labor time. Because this particular tool manufacturers cost per hour must be at least as high as ours, we think that this comparison gives an indication of the economical way in which we are now operating our tool making department.

MTM FOR MAINTENANCE WORK

The latest MTM installation we have made in our company has included our maintenance departments. For this type of work we have used the so-called UMS (Universal Maintenance Standards) approach, which is a special form of MTM application. Time does not permit me to go into a specific description of UMS. I will have to be content to state that this new form of MTM application has opened up new ways for methods and motion study in the whole field of maintenance work.

Since the latter part of 1958 we have with great success used UMS standards as a base for planning and incentive standards on practically all types of mechanical and electrical

maintenance work. At the present time we have approximately 70 maintenance workers on UMS incentives. Their work is both planned and measured with this special form of MTM application. The volume of incentive coverage for these workers can not be maintained at the same level as production workers. We can, however, cover about 75-80% of the mechanical maintenance work time and about 80-90% of electrical. But as far as the performance level is concerned, then it is the same, for all practical purposes, as that of the production workers. The maintenance workers have so far been able to maintain a performance of about 15% above the MTM norm.

The installation of MTM in our maintenance departments has substantially increased maintenance capacity. It has at the same time, through incentives, provided the workers with an opportunity for increased earnings. This increase in maintenance capacity and the increased earnings opportunity for the workers has been of important consequence to us. We have been able to reduce a number of personnel in our maintenance departments and at the same time shifted the emphasis of our maintenance work from repair of broken down equipment over to more preventive measures, so that we can avoid or at least reduce the number of break downs. Each per cent we can eliminate of production shut downs has a large economic value. The increased earnings opportunities will make it easier for us to recruit skilled workers into our maintenance departments in the future. Previously, the shortage of qualified maintenance workers was one of our most difficult problems. We feel that this problem now will be considerably reduced as a result of the UMS installation.

STILL NOT FINISHED

After you have listened to my presentation on how we use MTM, you may probably have the feeling that everything we do is covered by the MTM standards. But I do not want to leave you with such a false impression. I would like to say in spite of the fact that we have worked for approximately ten years with MTM we have today covered only about one half of our 2200 workers with MTM incentives. I should also like to mention that we have not proceeded with unnecessary haste pushing MTM forward into new areas. Instead we have patiently waited for the proper moment before venturing into new areas of MTM application. We do not have as our goal a 100% coverage of all our various types of work. A large portion of our production is process controlled, which significantly reduces the importance of MTM in this area. We also have some work areas where time study or some other form of work measurement is more suitable. And there certainly are some areas left where it simply is uneconomical to apply any form of work measurement.

We have estimated that we can increase our MTM coverage to approximately 70-75% of our total work force. We estimate that it will take us another three years to reach this point.

INTERNATIONAL

MTM AND PERFORMANCE LEVEL ESTIMATION

by

Pierre Fornallaz (Zug, Switzerland)

One of the advantages of the predetermined time-methods as against classical time-study lies in the fact that by the application of predetermined time-intervals performance level estimation becomes obsolete. With that the highly controversial subjective element of the ascertainment of handicap time is excluded. This undoubtedly existing advantage must, however, offer no illusion over the fact that, with analytical handicap-time ascertainment there emerges another problem demanding equally subjective consideration: a grasp of the working method and its critical evaluation by the job-study man. Anyone who has himself conducted MTM analyses in industry knows that especially with complex motions such as "picking up" or "joining" there can arise doubts again and again as to which the correct MTM analysis of the element might be. The definitions of the elements and their variants, as well as the theories that have been formulated for the complex elements, do not suffice to designate the observed motion without ambiguity. The job-study man is confronted here with problems of measurement, and only experience can help him further along.

All subjective deviations must necessarily lead to variation-spreads. I have made it my task to grasp the total variation of the results of an MTM analysis conducted by several trained MTM men on the same work process, and to compare it with the variation that comes about through performance level estimates done by several observers.

The work process chosen comes from precision tool industry. It concerns the riveting of a silver rivet onto a contact rail. The rivet is very small (height, 2 mm; head, 0.2 mm; shaft, 0.1 mm), and must be grasped with a pair of tweezers. The riveting is done on a small pedal press. Five women workers, designated by the foremen of their respective departments as being acquainted with the work, were filmed while executing this riveting operation. To be sure, the sequence showed the performances to be quite varied, enough so that certain doubts concerning the qualification and the sufficient breaking into the job of three of the operators could exist.

Operator	Average Time/Pc. TMU	Longest Time/Pc. TMU	Shortest Time/Pc. TMU
A	217	270	205
B	120	145	97
C	217	254	157
D	130	147	112
E	209	232	184

The film was shown to 15 trained MTM men on the occasion of their final examination in the 3-week course; the assignment was to perform an analysis of the job process. The film could be seen any number of times; furthermore, worked pieces as well as tools stood at the observers' disposal, in order to enable them to try out the work themselves. That way the MTM men gained an insight into the various work methods, skills, and tempo of the women operators, and could form an idea for themselves about the demands made by the work.

The 15 analyses yielded an average value m_1, of

$$m_1 = 133.7 \text{ TMU}$$

with an average quadratic deviation s_1, of

$$s_1 = \pm 17.4 \text{ TMU} = \pm 13\%.$$

With the survey of the analyses it was at any rate ascertained that they contained a series of obvious errors which strongly influenced the variation-spread found. These errors were corrected: nevertheless—as we shall yet see—strict care was taken to leave undisturbed all appearing variants as long as they contained no unequivocal infringements upon the rules of

MTM theory. The 15 analyses corrected in this manner yielded an average value m_2

$$m_2 = 138.4 \text{ TMU}$$

with an average quadratic deviation s_2, of

$$s_2 = \pm 9.5 \text{ TMU} = \pm 6.9\%.$$

The largest value amounted to
156.1 TMU = 113% of m_2
The smallest value amounted to
125.3 TMU = 90% of m_2

We conclude, therefore, that the average value was changed little (3.5%), and that, on the other hand, the average quadratic deviation receded to a round half-value (56%).

Examination of the remaining differences showed that the analyses of the movements in their entire course agreed with those of the movements taken singly, and that, on the contrary, significant differences could be ascertained with four of the complex elements.

Let us take a closer look at these variants:

1. Picking up the contact rail:

A	B	C	D	E	
G4B G2	G4C G2	G4B 2G2	G5 2M2A 3G2	G4C 2G2	
14.7	18.5	20.3	20.8	24.1	TMU

With the exception of Variant D, which appears to be quite fanciful, all variants exhibit the same structure. A decision between G4B and G4C, as well as between a single and a double G2, is for all practical purposes a question of measurement.

2. Grasping rivet with tweezers:

A	B	C	D	E	F	
P2SD M2A	EF P2SE M2A	(M10B) EF M2C P2SE M2A	EF P2SD M2C	P2SD AP2	2EF P2SE M2A	
23.8	25.5	27.5	31.1	32.4	32.8	TMU

Here it had to be decided whether, preceding the attachment of the tweezers, a correctly lying rivet (with shaft on top) should have to be pinpointed with a notation EF. The joining, on account of necessary precision, is a P2; the choice of the handling factor, D or E, is, on the contrary, a question of measurement. The closing of the tweezers is either an M2A (stroke) or an M2C (higher degree of control), a factor without significance, temporarily at any rate. The variant E appears to be rather a solution to displaced motion, yet it cannot be completely disregarded when a paraphrase of AP2 is considered: absence of a motion, momentary hesitation. Unequivocally.

3. Attachment of rivet to appliance; opening of tweezers; withdrawal of hand:

A	B	C	
P2SE M2B (R6E)	P2SE M2B R6E	P2SD M2B R6E	
18.2	22.6	28.2	TMU

Again we find simple or difficult handling at the attachment a measurement problem. While the opening of the tweezers is clearly analyzed, it becomes difficult, as a consequence of the subtlety of the movement, to decide whether the withdrawal of the hand is a decisive time factor or whether it should be left out.

4. Setting rail onto rivet shaft and riveting on in the appliance

A	B	C	D	E	
M2C P2SD M2A	P2SD P1SE	M2C P2SD G2) M2A)	M2C P2SD G2) M2C)	M2C P1NSD P2SD	
25.8	27.4	29.4	29.4	39.8	TMU

With the exception of B all variants foretell a brief M2C-yield. The attachment of the rails by riveting (on the rivet shaft) is designated uniformly as P2SD. For the affixing of the rails in the appliance we nevertheless find 5 solutions. The motion sequence in Variant E is different from that in the other variants: affixation is done before the joining of rail and rivet shaft.

How do these variants work out temporarily? We ascertain that in the four cases examined there exist temporary differences of $\pm$21 to 24% from the momentarily adopted average value. It is at any rate probable that these differences will partially disappear. Thus, for an example, I have designated for all four cases that solution which appears to me personally to be the most practical:

Element 1:	Solution E	= 24.1 TMU
Element 2:	Solution D	= 31.1 TMU
Element 3:	Solution A	= 18.2 TMU
Element 4:	Solution D	= 29.4 TMU
	Total:	102.8 TMU

The sum of 102.8 TMU differs from the sum of the average values of the four elements by less than 1 TMU.

Even if this conclusion is reassuring, it must not mislead us into believing that the analysis of complex elements does not lead to problems demanding subjective consideration and that with that, there can not emerge any significant variation spreads. Any comparison of this spread with that resulting from performance level estimates can only be an obtrusive one.

The same film was shown to a group of 21 production people from the watchmaking industry: here each single person had to estimate the performance level of the five women workers. Here we must emphasize that not only differences in work intensity were to be ascertained—as, for example, with the well-known SAM films—but also differences in the effectiveness of methods applied. This is thoroughly desirable, as it corresponds to the conditions that the time-study official normally encounters in the shop.

The result of the 21 x 5 = 105 estimates yielded an average value m_3, of

$$m_3 = 160 \text{ TMU}$$

with an average quadratic deviation s_3, of

$$s_3 = \pm 28.1 \text{ TMU} = \pm 17.6\%$$

The average value m_3 is around 15% higher than m_2. This difference is traceable to non-uniform concepts of normal performance, and is irrelevant to the problem that concerns us.

Comparison of the average quadratic deviations is, on the other hand, very interesting. We ascertain that the variation spread of the performance level estimates amounts to around 2-1/2 times the spread of the MTM analyses. This result becomes the more impressive when we consider that the 15 MTM analyses were for the most part made by persons not at all or only very little acquainted with the work performed. It may be assumed that the average quadratic deviation would have appeared as even smaller than s_2 if the MTM studies in the shop had been carried out by job-study men who are experienced and thoroughly familiar with the work.

Of the 21 factory personnel from the watchmaking industry it can be said that they had not been specially trained in performance level estimation. All told, and at any rate under normal shop conditions, one may expect an increase rather than a decrease in the average quadratic deviation.

In summary it may be concluded that:

1. MTM analysis of complex movement elements is to a great extent dependent upon subjective considerations. For the purposes of the precision tool industry, it would be desirable to differentiate with elements such as "joining" or "grasping" in a more subtle way than MTM does today.

2. The subjective considerations with the comprehension of the work method by means of predetermined time elements have a much lesser effect on handicap time than do the subjective considerations that become necessary with performance level estimation. The reason is first of all to be sought in the fact that in the first case the observer's attention falls exclusively on the work method, while in the second it is definitely directed at the person observed.

MTM - ANALYSIS - CHART

Work piece: Contact rail — Classif. No.: Film FZ 326
Work process: Rivets of silver onto rail
Operators: 5 women operators A - E — Date: July 1, 1959

	Description - Left Hand	LH	TMU	RH	Description - Right Hand
1.	Hand to contact rails	R20C	11.4	(M10B)	Hand with tweezers to rivets
	Grasping rails	G4C	12.9		
	Releasing	G2	5.6		
	Regrasping	G2	5.6	(M2C)	Tweezers in position
2.			7.3	EF	Picking out rivet shaft
			21.8	P2SD	Tweezers on shaft
			2.0	M2C	Tweezers closed
3.	Rail to appliance and regrasping	(M12B G2)	7.9	M10C	Rivet to appliance
			16.2	P2SE	Laying into appliance
			2.0	M2B	Tweezers opened
4.	Rail to appliance	M2C	2.0	(R5E)	Hand withdrawn
	Rail set upon rivet	P2SD	21.8		
	Rail in appliance affixed	G2 M2C	5.6		
			8.6	LM18	Pedal pressed down
			8.6	LM18	Pedal released
	Piece of work laid away	M8B	5.9		
	Released in receptacle	RL1	2.0		
			147.2	TMU	

NEWS ITEMS

MTM FOR MAINTENANCE WORK - UMS

by

SVENSKA MTM-FÖRENINGEN (Swedish MTM Association)

Swedish industry has in general reached far on rationalizing and cost control at production departments. The new work study techniques have been of good help. But with the type of non-repetitive jobs which are represented by maintenance work and where the time for one and the same job varies from time to time according to external factors, these work study techniques have been very little in use. Our industry has great difficulties as regards rationalizing, effective planning and cost control on maintenance work because the conventional work studies are not suitable for measuring and control of this type of work.

It is impossible to predetermine working methods and exact standard times for maintenance work. Instead one has to establish certain basic methods for using tools, etc., and to give directions how a work shall be carried out. If one determines the time for the work it is necessary that this time represents the average conditions during which the work will be carried out.

The experience has shown that it is very complicated and takes a long time to determine representative times for maintenance work with conventional time studies. This is perhaps the main reason why a practically used system for time determination of maintenance work has not been developed. When a new way of using MTM—Universal Maintenance Standards—UMS—was developed in USA this was received with great interest by the Swedish industry.

The Swedish MTM Association and UMS

AB Volvo Skövdeverken at Skövde was the first enterprise which installed UMS, and that was in 1957.

During 1958 the Board of the Swedish MTM Association took up the question of UMS for discussion. According to the statutes the Association has as its purpose to deepen the knowledge of MTM and to work for a correct use of MTM. With regard to these statutes the Board decided that the Association should undertake information about UMS.

At the annual meeting in 1959, with over 230 participants, some addresses on UMS were held. These addresses have been published in a booklet by the Association.

The curriculum for UMS had been worked out and was presented at the annual meeting. The curriculum includes two shorter information conferences of UMS and a 2 week course as below:

UMS 1 - A concentrated 1 day information conference for the managers of the member enterprises. This conference is intended to give the management information about this new technique, how it shall be used and installed in an enterprise and about the results which can be achieved.

UMS 2 - A 3 day information conference for leading work study personnel and leading personnel at maintenance departments. This conference will give these categories possibilities to judge the UMS technique, how much it involves of work and costs and what results it can give.

These two conferences include mainly the following items:

1) Information about MTM

2) Maintenance work
   Development and problems
   Pre-requisites for rational maintenance work
   MTM for maintenance work—UMS

3) The UMS method
   Principles and use

Pre-requisites for UMS
Experiences and results

4) Cooperation with experts

5) Assistance from the management

The purpose with these two conferences is to give such information to the management, leading work study personnel and leading personnel at maintenance departments that the member enterprises can take stand to the question of applying this new technique at their enterprises.

The UMS application involves many difficult problems which can be solved by technicians experienced in the UMS technique. The Association recommends therefore that the member enterprises seek experts as help to their own trained technicians. According to the experiences hitherto accurate preparation work and planning work by their own personnel can mean a considerable reduction of the costs for experts.

The Association arranges therefore also courses as below:

UMS 3 - A 2 week course for personnel at member enterprises who are responsible for installation of UMS. The course intends to give sufficient knowledge so that the participant in cooperation with experts shall be able to carry out a UMS installation. The course includes a week theory and a week practice with visits at enterprises with UMS installation.

UMS Conferences During 1959 and 1960

The first UMS conference was arranged in April, 1959. About 30 representatives for the management of more than 20 enterprises participated in a 1-day information conference in Stockholm.

In May 1959 a 3-day conference was arranged, with almost 30 participants. In all, the Association has arranged five UMS 2 conferences. That means that more than 150 persons have received thorough information about the principles and use of UMS.

During the autumn of 1959 the first 2-week course—UMS 3—with 16 participants was held. The practical part of the course was held at AB Volvo Skövdeverken and Husqvarna Vapenfabriks AB. Two more UMS 3 courses have been arranged during 1960. In all, 44 UMS technicians have received training through the Swedish MTM Association.

The interest for these UMS conferences is still great. The Association therefore intends to continue with this activity during 1961 in accordance with the above curriculum. For the spring of 1961 are planned UMS 1 and UMS 2 conferences as well as a UMS 3 course.

Olle Hasselqvist

February 1961

The above fifteen MAAMA personnel have received Certificates of Recognition for the successful completion of 120 hours of classroom training in the application of Methods-Time-Measurement. Front Row: Mr. Wilbur D. McLaughlin, Instructor, Mr. William H. Weaver, Mrs. Velia O. Picciotti, Mr. Wallace E. Sheaffer Jr., Mr. Ellwood J. Menear, Mr. Anthony J. Rossi. 2nd Row: Mr. Julian L. James, Mr. Henry H. Green, Mr. Martin E. Baker, Charles R. Reinnger, Mr. Joseph G. Myers, Mr. James W. Hurd. 3rd Row: Mr. James R. Barrick, Mr. Savino D. Vasco, Mr. Donald J. MacEwen, Mr. Joseph Ozimek and Mr. Harold L. Goodemote, Chief Industrial Engineering Division, Directorate of Maintenance. Abbreviated "MTM," the procedure is a relatively new development in the field of Industrial Engineering and is primarily concerned with the processes of improving work methods and establishing labor standards. The class was composed of Industrial Engineers, Engineered Time Standards Analysts and Production Specialists, and, for the first time at Middletown AMA included a member of the fairer sex on the class roster. The training program was conducted over a six-week period during February and March. Sessions were held in the training classrooms in Building No. 138. Training in this technique increases the technical capability of those engineering components whose mission includes participation in work measurement and methods improvement programs. By formal definition, Methods-Time-Measurement is a procedure which analyzes any manual operation, or method, into the basic motions required to perform it and assigns to each motion a predetermined time which is based upon the nature of the motion and the conditions under which it is made.

MTM Courses are conducted in conformance with the requirements of the MTM Association for Standards and Research, Ann Arbor, Michigan. Middletown AMA holds a Sustaining Membership in the Association. Certificates of Recognition are awarded to those who successfully complete a four-hour examination prepared and graded by the Association, and qualifies the recipient to utilize the MTM technique. The technique is used throughout industry and government, both nationwide and internationally. Instructor for the course was Wilbur D. McLaughlin, who is certified by the MTM Association as the Licensed In-Plant Instructor at Middletown AMA.

Jerome Goldman delivers graduation certificates to top graduates in Brookley Air Force Base's thirteenth MTM application training course. Graduates (left to right) are: James T. Kraver, David L. Tinnes, and Peter G. Stahl, all industrial engineers.

MTM TRAINING COURSES

Brookley Air Force Base graduated its thirteenth class in method time management application recently. The class was made up of industrial engineers—some branch chiefs. Jerome Goldman, instructor, presented certificates to: (front, left to right) Goldman, Hugh G. Barrington, William E. McKay, Peter G. Stahl, Sheridan O. Moak, Earl W. Shirley, James T. Kraver, and George G. Stennis; (second row, left to right) William J. Sommers, David L. Tinnes, E. Haschal Hyde, Thomas S. Lynch, Robert C. Finley, Bill A. Tolson, and Hubert M. Porter; (back row, left to right) Lawrence F. Chandler, Harrell L. Landbeth, William O. Howard, Sr., James P. Griffin, and Evans R. Winter. Unavailable for the picture was graduate Wilbur L. Paulk.